Education and Technology Series

THE EFFECT OF COMPUTER TECHNOLOGY ON COMPOSING PROCESSES AND WRITTEN PRODUCTS OF GRADE 8 AND GRADE 12 STUDENTS

AVIVA FREEDMAN, Principal Investigator
LINDA CLARKE, Principal Investigator

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ANTONIA MILLER

This research project was funded under contract by the Ministry of Education, Ontario. It reflects the views of the authors and not necessarily those of the Ministry.

Chris Ward, Minister
Bernard J. Shapiro, Deputy Minister

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ABSTRACT

This study investigated the effect of computer technology on the composing processes of students in Grades 8, 12G, and 12A. Students' writing in two conditions were compared: writing by pen and writing with the aid of a word processor. Specifically, the study addressed the questions of whether computer use led to an increase in revision and/or an improvement in quality.

Data were collected over one academic year from 13 classes (as well as two supplementary groups) and assessed for differences. First, students' pre-test essays, post-test essays, and all compositions written for the course under study were subjected to varying levels of analysis: classification and categorization of revisions between first and final drafts; forced-choice quality ratings comparing first and final drafts; and evaluation of the scripts according to a set of specified rhetorical criteria. Second, extensive classroom observations produced descriptions of the differing pedagogies with respect to the teaching of writing as process, codings of classroom writing behaviours, and video recordings of computer screens of specific students' composing processes.

The results of the revision analysis revealed that, for all grade levels, there were more changes in essays written entirely by pen than in those written on the computer. However, essays that were begun by pen and revised on the computer revealed more revisions

than those written entirely on the computer. The number of revisions in such essays approached that in essays written by pen.

The forced-choice quality ratings, used to determine if revisions improved the final draft, indicated no difference as to condition: students were as likely to improve their essay revising by pen as they were revising by computer. Rhetorical analyses also revealed few differences by condition.

Coding of students' behaviours as they wrote indicated that the computer diverted a significant amount of time from the task of composing. Furthermore, the time devoted to the computer seemed to come at the expense of interactions with other students and the teacher over texts in progress. In addition, analysis of the video-tape transcripts of composing sessions revealed that for many students, the correction of typographical errors was a persistent interruption to their composing with a computer.

One conclusion of the study was that a specialized pedagogy must be developed to guide the teaching of writing with a computer. The final chapter outlines some aspects of such a pedagogy, which involves modifications of and extensions to a process approach. (An incidental finding of the current research was that students of teachers committed to a process approach made significantly more revisions and were more likely, consequently, to improve their pieces.) Further research investigating the effects of computer use should be undertaken, once such a pedagogy is in place.

INTRODUCTION

From the beginning of the eighties and the seminal work of Papert (1981), educationists have been challenged by statements concerning the power of the computer as a tool in learning in general and, a little later, by statements about its great potential in enhancing children's writing development. A typical comment is that of the eminent rhetorician, E.P.J. Corbett, who enthused in the foreword to Computers and Composing: "After only a week of hands-on experience with this wondrous machine, I acquired a keen sense of its potency and its potential" (1984, p. xii).

As Chapter Two, which reviews the relevant scholarly literature, will reveal, Corbett's response was similar to that of many writers in their first encounter with the word-processing facility of the computer and of many educators alerted thus to its potential for encouraging growth or improvement in students' compositions. Needless to say, the general hue and cry about student illiteracy among the public and in the press made such a potential extremely attractive.

It was in this context that the following study was undertaken. Specifically, its goal was to compare the composing processes and products of school-age children in two conditions: when writing by hand and when writing with the aid of a word processor. Since the particular value ascribed to the word processor is its facility in easing the revising process, an important facet of this investigation

was to examine differences in the nature of the revisions performed under the two conditions. At the same time, it was recognized that quantity or type of revision need not predict quality, and so other measures were included as part of the comparison.

The research method was partly situated in the conventional educational research paradigm. There were experimental and control groups, pre- and post-tests, as well as extensive analyses of the texts produced. In order to enrich our understanding of the results of such research, however, we went beyond the conventional methodology. Wherever possible, we observed the writing that took place in the classes under study: researchers were assigned to all writing classes, whether the writing was to be by pen or by computer, and frequently the composing of specific pieces was videotaped for closer analysis. In the end, it was this extensive observation and this close analysis of composing processes and behaviours, that gave meaning and educational relevance to the results of our statistical comparisons of the writing produced.

CHAPTER TWO: LITERATURE REVIEW

Introduction

Recent research has revealed the composing processes of experienced writers to be characterized by effective use of revising strategies at the micro and macro levels (Sommers 1979, Flower and Hayes 1981.) In contrast, inexperienced writers' tend to write as if the text were being engraved in stone, fixed and immutable. They begin by writing the first sentence and in a sequential process, continue to the end. Their thoughts often "halt at the boundary of each sentence rather than move on" (Shaughnessy, 1977, p. 226). When finished, they "do not do much to the text and what they do does not usually improve the text in any significant fashion" (Collier 1981, p. 3). "Most do only two drafts, the second merely a neater and more legible copy of the first" (Kane 1983, p. 1).

A question being asked, with the recent advances in computer technology, is whether word processing programs can improve the way inexperienced writers compose. Two primary areas where word processors can provide help have been identified. First, the new technology is believed to encourage students to view text as being easily movable and thereby to encourage revision. Marcus (1984) describes computer text as words "written in light, a fluid medium that offers little resistance to physical manipulation" (p. 58). In addition, the necessity of recopying handwritten text caused by revising is eliminated. The result is believed to be a more efficient use of writers' time.

Support for the use of word processors abounds in the form of testimonials in both computer and educational journals. For example, Ryan (1985) enthusiastically discusses the newest features of the "surprisingly uncomplicated world of word processing", assuring readers that they are "in for a conversion experience". Wilson (1984), also a professional writer, comments on the elimination of the mindless drudgery of recopying revised text. Educators tell of how they began their studies of students' use of computers for writing as a result of being won over themselves. Moran (1983) discusses his release from writer's block as a result of working in such an easily changed medium, noting the enormous convenience of making later revisions and reprints. He speculates that for students, the three to four draft sequence of revisions that is possible in one class period using computers would take three to four weeks when handwritten, if it were done at all.

In contrast to such enthusiasm, a warning note is sounded by several professional writers. Dagg (1985), for example, worries that writers who go straight to the screen may find that "their script looks presentable, but will it be writing with depth?" (p. 4). And Bailey (1985) expresses a more profound concern about the technology. "Word processors remind me of my big car. Yes they are things of beauty and indeed mystery but like my car I fear they would form a barrier between me and landscape I wish to travel" (p. 5).

All these statements, on both sides of the issue, derive primarily from introspection and speculation, and clearly demand controlled testing. Increasingly, in recent years researchers have begun to perform just such investigations, that is, analyses of the effects of the word processor on writing processes and products.

Such studies have been summarized in a number of annotated bibliographies: Nancarrow, Ross, and Bridwell (1984), Schwartz and Bridwell (1984), Appleby (1984), and Hawisher (n.d.). The brief review that follows relies especially on the work of Hawisher.

Research Into Effects of Word Processors

Not surprisingly, many of the early reports on the introduction of the computer into the composing process were informal, personal, and anecdotal. Without dismissing the stimulating effect of such reports, the following discussion will focus on the more disciplined research studies that followed. More specifically, all the research that will be discussed below addresses, from one perspective or another, our central question as to the effect of word processor use on the written products and writing processes of schoolchildren. We do not include any analysis of survey studies that focus solely on determining the attitudes of students after their exposure to the computer -- unless the influence of the technology on their compositions or composing processes is also examined.

A further qualification is that the following studies, like ours, all focus on the effect of the computer when used as a word processor. In other words, what is not being considered is that body of work that investigates the computer as an instructional

delivery system. A number of programs have been developed to encourage invention (e.g., Burns 1984), to prompt editing (e.g. THE WRITER'S WORKBENCH by Bell Laboratories), to encourage planning (e.g. THE WRITER'S HELPER by Wresch), or to do all of these. The potential usefulness of these specific programs, or of such programs in general, however, is something that must be investigated separately and independently of the question that is the focus of our study. For that reason, all such studies are considered beyond our province.

Table 2.1, based on the work of Hawisher, summarizes key features of the design and findings of ten quantitative experimental studies investigating the effects of the word processor. Note that all studies focused on school-age children, some on low achievers and others on average and enriched pupils. The numbers of students involved in most studies were relatively small, and the duration of the treatment, that is the exposure to writing with a computer, was relatively brief, except for three studies that looked at writing performed over 36 weeks: those by Daiute (1986), Duling (1985), and Pivarnik (1985).

Certain common findings emerged from these studies. On the whole, students seemed to have positive attitudes towards writing with the computer; their finished products tended to have fewer mechanical errors; and many students wrote longer pieces. There were conflicting results, however, in two areas: number of revisions and quality of final pieces. As Table 2.1 reveals, where these variables were measured, there were two studies showing increased revision, and three not; four studies showing improved quality, two

not, and two mixed. What is particularly significant is that, in three of the six studies in which computer use led to a positive outcome, the students were defined as basic or low achievers. Conversely, for each study in which basic or low achievers were involved, some improvement was measured.

Because of the potential effect of maturation, college- and adult-level studies of the effect of word processor use are reported separately from the school-age studies. See Tables 2.2 and 2.3. Here too, the numbers are not great, and the durations are either relatively short or unreported. Furthermore, for three of the college-level studies, students sometimes wrote the first draft by pen and only used the computer for revision.

In fact, the college-level research is more negative in its findings with respect to computer use than the school-level studies. Only one study showed improvement in quality -- and that was for a class of basic writers. The findings on the adult-level research were once again ambiguous.

To summarize for all these studies, of the fourteen that measured quality, five showed improvement, and three pointed to mixed findings. Of those that showed some improvement, four involved basic students. Of the nine studies that measured revision, three showed increases; one of these three involved basic students.

TABLE 2.1: SUMMARY OF SCHOOL-LEVEL STUDIES INVESTIGATING EFFECTS OF WORD PROCESSING

(This table is based on Hawisher, n.d.)

STUDY	SAMPLE	N	DURATION (WEEKS)	COMPOSED AT COMPUTER	INCREASED REVISION	IMPROVED QUALITY
BURNETT (1984)	LOW ACHIEVERS GRADES 1-5	10	8	Y	--	Y
CIRELLO (1986)	BASIC GRADE 10	30	20	Y	Y	N/Y
DAIUTE (1986)*	GRADE 7 GRADE 9	57	36	Y/N	--	N/Y
DULING (1985)	GRADE 9	20	36	N	N	N
KAPLAN (1986)	GRADE 5	56	5	Y	N	Y
MILLER (1984)**	GRADE 6	28	5	N	N	--
PIVARNIK (1985)	BASIC GRADE 11	76	36	Y	--	Y
WETZEL (1985)	GRADES 3, 4, 5	36	10	Y	Y	N
WOODRUFF, LINDSAY, BRYSON, & JORAM (1986)	AVERAGE AND ENRICHED GRADE 8	16	1	Y	--	Y
WOOLEY (1985)	GRADE 5	120	2	--	--	N

* The software program included revision prompts.
**All first drafts were written by pen.

TABLE 2.2: SUMMARY OF COLLEGE-LEVEL STUDIES INVESTIGATING EFFECTS OF WORD PROCESSING

(This table is based on Hawisher, n.d.)

STUDY	SAMPLE	N	DURATION (WEEKS)	COMPOSED AT COMPUTER	INCREASED REVISION	IMPROVED QUALITY
COULTER (1986)	COLLEGE 1ST YEAR	62	16	Y	N	N
HARRIS & HULT (n.d.)	FIRST YEAR COLLEGE - REMEDIAL AND REGULAR	56	SEMESTER	--	N	--
HAWISHER (1987)	COLLEGE 1ST YEAR	20	16	Y/N	N	N
KING, BIRNBAUM & WAGEMAN (1984)	COLLEGE BASIC WRITERS	10	16	Y/N	--	Y

TABLE 2.3: SUMMARY OF ADULT-LEVEL STUDIES INVESTIGATING EFFECTS OF WORD PROCESSING

(This table is based on Hawisher, n.d.)

STUDY	SAMPLE	N	DURATION (WEEKS)	COMPOSED AT COMPUTER	INCREASED REVISION	IMPROVED QUALITY
GOULD (1981)	IBM RESEARCHERS	10	--	Y	Y	N
HAAS (1986)*	EXPERIENCED ACADEMICS	15/8	--	Y	--	--
HAAS & HAYES (1986)	EXPERIENCED ACADEMICS	15	--	Y	--	Y/N

*Haas found less planning on computer.

Qualitative Studies

In her review of the literature, Hawisher distinguishes the kind of experimental studies described above from studies whose primary methodology and research goal is qualitative. Such studies have focused largely on college-level and professional writers. Two researchers, however, have looked at school-age children. Daiute (1984, 1985) observed nine- to twelve-year-olds composing with a computer, with the aid of a word-processing program called CATCH. This program contains revision prompts and consequently is more like an instructional delivery system. Even with such a program, however, Daiute's results are ambiguous: most students did in fact revise more, but such revisions did not lead to an increase in quality. On the other hand, Flinn (1985), in a 36-week study of eight sixth graders, reports that the computer children did in fact revise more, and that they revised more at the macro level. The pen and paper students focused more on surface level revisions.

Several qualitative studies also analysed the written products quantitatively, e.g. Bridwell, Johnson & Brehe, 1986; Bridwell, Sirc & Brooke, 1985; Collier, 1983; Harris, 1985; Lutz, 1983; Nichols, 1986; and Schipke, 1986. (Note that all these studies focus on college-level students or experienced writers.) Their findings were similar to those of the experimental studies presented above: texts were longer and mechanically more correct when composed on the word processor. However, when revision and quality were examined, the results were mixed.

A finding of particular note, at both the college and professional levels, is the following. Nichols (1986) found that

the basic level writers he observed simply transferred the strategies they had already developed to the new technology. That is, they simply did "more of the same" (p. 90). In much the same way, Schipke (1986) found that professional writers used the computer technology to allow them to carry out their already established routines more efficiently.

Ethnographic Studies

Four studies attempted an ethnographic analysis of the use of the word processor for writing in the context of the culture of the school and classroom. Dickinson (1986) looked at a combined first and second grade class and discovered that writing at the computer was a more collaborative activity than writing with pen and paper. This finding is paralleled by observations made in Reid's 1985 study of fourth graders as well as Wahlstrom and Selfe's 1986 study into college writers in a computer writing lab. A more sobering note is sounded by Herrmann (1985) who suggested that the use of computers in a writing class intensified the academic differences among the eight high school students she observed.

Relationship to Current Study

These various studies, in different ways, have suggested directions for the current study. First, it is clear that, in most cases, students were not given ample opportunity to write with the computer: that is, they were not given enough sessions with the computer and enough time to absorb what they had learned in these sessions. For this reason, our goal was to give students an

academic year in which to master the use of the word processor and to develop composing strategies appropriate to the new technology.

Secondly, our primary questions were directed towards those areas where ambiguity remained. Thus, nearly all the studies that investigated this variable found that writing with a word processor led to greater mechanical control. Consequently, this was not a question we chose to address. Instead, we focused on those variables for which the findings had been mixed: specifically, whether computer use led to an increase in revision (unrelated to editing changes) and whether such use led to an improvement in quality.

Finally, as Hawisher (n.d.) has pointed out, a major limitation of both the quantitative and qualitative research reported thus far has been its lack of detail. Not enough has been presented concerning instructional methodologies, both relating to the writing pedagogy as well as computer use. This failure is related in part to the final reporting but also to the essential design of the studies. For this reason, our own design has included extensive classroom observations -- both in the treatment classes, where the computer has been in use, as well as in the pen-and-paper writing classes. In addition, this report will include extensive discussions based on these observations.

CHAPTER THREE: DESIGN

Anyone involved in educational research will attest to the inevitable distance between the design that is projected and the reality that ensues. This study was no different. The following discussion, consequently, will begin with a description of what we proposed to do originally, and this will be followed by a description of the study that in fact took place. Some changes were conscious and deliberate (for example, the kinds of classes involved), some came about as a result of limited co-operativeness, and others -- the most significant -- as a result of certain intractable educational facts.

As we shall see, the kinds of modifications imposed by educational realities can sometimes limit, at other times enhance the original design. What is essential is that the nature of the constraints imposed by these educational realities be explored and understood in the context of the research and educational goals implied in the study.

Projected Population

Students. Our original goal was to focus on twelve classes: four Grade 8 classes, four 12G, and four 12A. In two of the four at each level, it was expected that students would be writing by pen, and in the other two, by computer.

TABLE 3.1: PROJECTED CLASSES

	Computer	Pen
Grade 8	2	2
Grade 12G	2	2
Grade 12A	2	2

Teachers. The original goal was to involve twelve teachers, one for each class to be studied. The essential prerequisite was that each teacher be committed to teaching writing as process. That is, the expectation was that all the teachers would be equally committed to teaching writing and to teaching it in such a way as to elicit a complete composing process on the part of the students, a process that was to include extensive revising, whether by pen or by computer.

In other words, we hoped that the writing pedagogy would be such as to elicit the best writing and the greatest development of which students were capable, at each level. And we expected that the pedagogy would be essentially similar in all classes.

There was strong reason in fact to believe that this might be the case. The particular board selected for our study had been involved in a massive professional development program with respect to writing over the past few years. Teachers at all levels had been attending extensive workshops focusing on the teaching of writing as process, using the approaches of Graves (1983) and Murray (1985) as models. The response to these workshops had been enthusiastic and the spillover effect into the schools was apparent. Further, teachers were selected to participate in this study on the basis of

their own response to an announcement that emphasized our need for teachers committed to teaching writing as process. Of the many who responded, the final number was selected on the basis of the consultants' advice, as well as on the basis of the following logistical considerations: whether their next year's teaching assignment was relevant and, for the treatment group, whether computers would be available.

Actual Population

Modifications to our original plan came about on a number of accounts. First, it was drawn to our attention that several schools were now offering writing courses at the senior level; such courses, however, were not slotted as specifically advanced or general. We were assured that these courses were populated by a fairly evenly distributed mix of students, some general, some advanced (as defined by the other English courses in which they were enrolled). Clearly, where possible, it was to our advantage to observe these year-long (or semester-long) courses in which the sole focus was writing, especially since computers were more likely to be available for such classes. Consequently, rather than restricting ourselves to 12A and 12G regular English courses, as we had planned, we added a third category of class at the Grade 12 level, the writing course, which included both advanced and general students. On the whole, this change was an advantage, since students were observed writing (either with or without the aid of a computer) over a far more extensive period of time than was allotted to writing in the regular English classes. The only unfortunate result of this choice was that fewer general level students were observed, since, contrary to the

teachers' initial impression, such courses were populated disproportionately by advanced students.

Secondly, it became apparent during our observations, that in no class was writing elicited only on the computer. At all levels, where the computer was introduced, students composed sometimes by pen, sometimes using the word processor. In the computer classes then, some students wrote in both conditions, and some students selected to write only by pen. (There was no instance of a student writing only with the aid of the computer.) This gave us the advantage of being able to compare the writing of the same students, writing under the two conditions. Further, the self-selection patterns of students with respect to the word processor were also amenable to analysis.

Both these modifications to our initial plan enriched the study. The third modification was to our disadvantage. Specifically, one 12G class was gradually withdrawn from the study over the course of the year. The teacher had volunteered to participate in the study and seemed enthusiastic at the outset. The pre-test was collected and the teacher assured us that he would devote six weeks beginning mid-October to writing. Every week the writing session was delayed further and further -- throughout the entire year. Our last call in mid-May garnered the assurance that he was going to begin the writing session as soon as he finished Hamlet -- which he was going to start the next day. Unfortunately, the writing in this class was to have been done by computer. To compensate, additional classes by one of the other participating teachers were enlisted for the study. The final design is described in Table 3.2.

TABLE 3.2: PARTICIPATING CLASSES

	Computer and Pen	Pen
Grade 8	2	2
Grade 12G	1	1
Writing Course (12A and 12G students)	2	1
Grade 12A	3	1

The teachers involved in this study will be designated by the letters of the alphabet, A - L. On the whole, there was one class to each teacher, with one exception. Table 3.3 summarizes the numbers of students participating in the study by grade level and gender.

TABLE 3.3: NUMBER OF STUDENTS AT EACH GRADE LEVEL BY GENDER

	Male	Female	Total
Grade 8	70	67	137
Grade 12G	41	46	87
Grade 12A	52	71	123
Writing Course	41	43	84
	204	227	431

Procedure

Pre-tests. At the beginning of the year, each teacher was asked to administer a pre-test. The format of that pre-test was as follows. On the first day of the administration, teachers were to announce to their classes that at some point within the next few days, students were going to be asked to write on the following topic.

> There are probably things happening in the world around you -- at school, among your friends, at home, in the country, in the world -- that you think ought to be changed. Select one, and write a composition (or an essay or article) to convince someone else (preferably someone who has the power to make the changes) that what you object to is really bad and ought to be changed.

A day or two after the initial announcement of the topic, teachers were directed to devote a whole class period to the composition of the first draft. Students were apprised of the fact that this was to be a first draft and that they would have ample opportunity for revision. First drafts were collected at the end of the class. The next time the class met, the drafts were returned and students were advised to write their final drafts. Both drafts were collected and submitted to the research team.

The goal, of course, was to allow students the opportunity to experience as much as possible of a complete writing process within the constraints of a controlled writing situation. Out-of-class time was allotted for generation and planning, according to whatever methods students had developed for themselves. Similarly, time was allocated to revision, allowing students to use all the strategies they had thus far acquired. Teachers were advised not to intervene in any way at all.

Post-tests. At the end of the year, students were to be given a similar post-test. (For the precise wording of both the pre-test and the post-test, see Appendix A.1 and A.2) Unfortunately, whether because of the press of end-of-the-year responsibilities or because their co-operativeness had already been taxed to the limit, fewer teachers generated the post-tests. Four teachers simply did not manage to assign this task. And the post-tests of a fifth were thrown into the garbage by an over-zealous secretary.

All the pre-tests and post-tests were written by pen. There were two reasons. First, logistically it was not possible to ensure that enough students in the experimental classes could have access to computers on two successive days in order to allow them to compose within the same constraints as the students writing by pen. More significantly, we wanted to see whether the expanded revising facility presumably developed by the computer would carry over into writing by pen under controlled conditions.

Class Writing. In addition to the pre- and post-tests, all the compositions that students wrote for the course under study over the entire year were collected, including all drafts and written prefigurings of any kind. This applied to writing by computer as well as writing by pen. When writing on the computer, students were encouraged to produce hard copies at the end of each session. The number and distribution of scripts collected are presented in Table 3.4.

TABLE 3.4: NUMBER OF SCRIPTS BY GRADE LEVEL

	Pre-test	Post-test	In Class	Other	Total
Grade 8	135	48	102	7	292
Grade 12G	79	47	81	0	207
Grade 12A	106	79	114	27	326
Writing Course	82	43	125	2	252
	402	217	422	36	1077

Classroom Observations. As indicated in the Introduction, writing classes were observed extensively. Specifically, for the classes in which writing formed only one portion of the course, each writing class was observed by one of the researchers. When writing was the sole focus of the entire course, as it was for three senior level English courses, at least 30% of the classes were observed.

Video Records. In addition, a VCR was attached to the computer screen of specific students as they were composing. Unfortunately, the technology was not available which would allow us to videotape the screens of all the different types of computers used in this study. The particular computers used in the various classrooms included Commodores, ICONs, and Apples. Only the Commodores could be videotaped, and only the Grade 8 classes used Commodores. For that reason, volunteers were generated in two other classes, to come to Carleton University on weekends in order to compose their school-assigned writing on one of the university's Commodores.

Supplementary Studies

As the discussion in the following section will reveal, the anticipated pedagogic conditions were not realized for all classes, both with respect to a process approach to writing as well as to computer use. This was a particular problem for the classes assigned to the computer condition. In fact, in only one Grade 8 class were circumstances ideal (or as ideal as is possible in an educational context), that is, the teacher was committed to a process approach and the computers were accessible in all senses. It became apparent consequently through our year of investigation, that the computer was not being given a fair trial in our study (although the reasons for this are extremely illuminating and of considerable import to those committed to the introduction of this technology in the schools). For this reason, we chose to conduct two supplementary studies following our principal project. The design for these studies will be described in full detail in Chapter Eight and their findings will be presented in Chapter Nine. Chapter Ten will present a discussion of the combined results emerging from both the principal project as well as the supplementary studies.

Pedagogy

As indicated earlier in this chapter, our goal was to involve teachers who were all committed to the teaching of writing as process so that the pedagogy would remain constant across all classes. The teachers selected, both on the basis of self-report as well as on the basis of evaluation by their consultants, all seemed to be so committed. Our expectation consequently was that the students

involved in the study would all have the same opportunity and encouragement to engage in a complete writing process, whether they used a pen or a computer. Observation of the teaching over the year, however, suggested that the situation was far more complex, that the pedagogy with respect to writing varied in important ways both among classes as well as within the same class over the space of a year. A discussion of the variation observed is presented in Chapter Four.

There was even more variation in the ways in which computers were incorporated into the writing class. The number of machines available, the times at which they were accessible, the kinds of software as well as hardware offered the students, all these varied from school to school, as did the degree of teacher knowledge about and commitment to use of the computer. All these variations are laid out in Chapter Five.

It must be stressed that this variety in writing and computer pedagogy was not an artifact of the experimental situation. These are the realities of the educational system. While researchers may feel frustration at their inability to control all such variables, those involved in developing curriculum, pedagogy, or professional development must be cognizant of and sensitive to all these factors and their interplay. Nothing in education is carried out in a vacuum, and it is for this reason that we overlaid our conventional research design with extensive in-class observation. In order to keep our research honest as well as to offer education planners the information they need, in the next two chapters, we will attempt to describe the nature of the complex realities observed.

CHAPTER FOUR: TEACHING STRATEGIES

All the teachers who participated in the study had defined themselves as process teachers in response to the announcement eliciting volunteers. Most had attended a series of workshops focused on explaining and dramatizing the kind of approach to the teaching of writing exemplified in the work of Donald Graves (1983) and Donald Murray (1985). Essentially such an approach implies the following. First, rather than a lecture-hall, the writing class becomes a workshop which is structured in such a way that students are encouraged to experience each stage of the writing process fully. Students are expected to take complete ownership of their writing, beginning with choosing their own topics. Strategies for generating topics, and then for generating ideas about the selected topic, are important parts of the process. (Peer conferencing is the generating strategy most associated with this approach.) Students are shown how to write their first drafts freely, allowing their texts to take unexpected directions. In other words, writing itself is seen as a way of discovering. The other side of the coin is that the first draft is always to be regarded as just that: a first draft. A major emphasis of the process approach is on revision. Writers are expected to revise their pieces many times -- in response to their own re-seeing, in response to their conference partner's suggestions, and in response as well to the teacher's probes.

This approach, then, is radically different from conventional composition pedagogy in which topics are specified, no guidance is given for generating ideas, and the last draft is typically the first draft made legible and spelled correctly. The teacher's role is radically different in the process approach. Rather than lecturing about writing, and especially about the product (i.e., a well-written composition), the process teacher is concerned to elicit in her classroom the kind of process that is likely to lead to good products. In other words, her role is primarily to facilitate and to orchestrate the whole: first to explain and model, and then to elicit the complete process by structuring the classroom -- its space and its time -- in such a way that the writing takes off by itself. Subsequently, she must unobtrusively keep track of each student's progress from the wings, in a classroom that resembles a studio: that is one in which each student is engaged in writing and is typically at a different stage in the process from neighbouring students.

Such an overall approach is amenable to many individual variations -- depending on the teacher's style and priorities, the students' needs, the level and focus of the course, the shape of the classroom, etc. Certainly, there was considerable variation in the classes involved in this study. In some cases, however, the differences could not be classified as variations on the same basic approach: what we were seeing was a very different pedagogy. Consequently, we have classified the pedagogy we observed into two broad categories: variations on a process approach; alternate pedagogies. This latter category includes examples of traditional

approaches to teaching composition as well as an example of what began as a process approach in the mind of the teacher but ended very differently in the translation into the classroom. Finally, there were two examples of classes in which the pedagogy changed dramatically over the year -- both in the direction of a more completely realized process approach.

Process Classes

Of the teachers observed, six clearly exemplified a process approach throughout the entire year. In all cases, these teachers had been teaching writing as process for a few years, and in some cases, the students whom they were seeing in the year of our study had already been introduced to this approach in previous years. Nevertheless, all began the year, or the writing unit, with a carefully orchestrated introduction. The following description of one teacher's introduction is typical.

Students were assigned to groups of two or three, based on the students' own preferences as to partners. Students were asked to make a list of three or four topics they might like to write about. Subsequently, they were asked to tell their partners something about each of these topics and their reasons for wanting to write. After listening to their partner's topics, students were encouraged to free-write a first draft. At this point, they were advised to conference once again. Specifically, they were to read aloud their drafts to their partners and to listen carefully to the responses and suggestions, with a view to revising their pieces. The following steps were written on the board for reference.

Step 1

What are some topics you would like to write about?

On which topics do you have particular thoughts and/or opinions?

In what areas do you have personal experiences and/or concerns?

MAKE A LIST

Talk to your partner about your choices.

Step 2

Select ONE topic from your list.

Talk to your partner about it.

Share your thoughts, opinions, and experiences.

Also, listen to your partner's thoughts, opinions, concerns, experiences about it.

Ask questions.

Start jotting down thoughts, opinions, experiences, etc.

Don't concern yourself with spelling, sentence writing, handwriting, etc.

Step 3

Start writing your first draft.

Naturally you will be writing in complete sentences. The idea is to see your ideas, thoughts, opinions, and experiences take shape in writing. New ideas will also

emerge in your mind as you are writing. Get these down too. Don't worry about the order of things at this stage.

Step 4

Read your FIRST DRAFT to your partner.

Have your partner LISTEN and offer suggestions or ASK QUESTIONS.

Reverse the roles. Do the same step again.

When you have listened and chatted, start POLISHING your first draft:

Taking out (-)

Adding (+)

Rearranging

This introduction was typical, but variations were common. Some teachers suggested methods of generating beyond talking, such as brainstorming ideas or words, clustering, making idea webs, etc. Some supplemented the initial staging of the process by modelling, that is, by going through the stages themselves, using the whole class or specific students as their own partners. In one class, in which most students were already familiar with the process, the teacher focused on what she knew to be their weakness -- the revising stages of the process. Consequently, she directed writing partners to make the following statements and ask the following questions during the post-writing conferences:

1) The part I like best is . . .

2) What is the one thing you want to say?

3) What changes will you make in your next draft?

At the same time, the following revision techniques were also listed on the board and were emphasized during conferencing.

1) Add material (specific materials).

2) Delete material.

3) Reorder sentences, paragraphs.

4) Re-define topic or change topic.

Final copy -- direct attention to mechanical errors.

After the introductory staging of the process, teachers in these classes gave up the podium, so to speak, and allowed the class to become a workshop. The writing sessions on successive days began with students picking up their writing folders as they came into the classroom and beginning where they had left off the previous day. While students were involved in the various stages of the process, teachers typically spent the entire session circulating among the writing groups, talking to students, and listening to drafts. They were skilful in offering prompts to help students see how essays might be improved and in giving advice on appropriate agenda for specific drafts. These interventions not only guided students in their own writing but also offered models for appropriate conferencing strategies. Unobtrusive though it may seem, such intervention at crucial moments in the process is undoubtedly what gives this

approach its particular power, illuminating for students the possibilities in a particular piece as well as the appropriate stance and range of strategies available for its composing.

Variations on the Process Approach

One teacher relied heavily on Parker's textbook, The Writer's Workshop, to teach strategies of invention, organization, and revision within the general workshop approach. Students worked at their own pace on assignments or exercises or journal writing, as specified in the text. In this context, they worked with assigned writing partners and were expected to read or listen to work read aloud, and to comment and help partners decide when a piece was ready for a final draft. Students were expected to use the text as a guide for revising and editing strategies. In addition, the teacher was always available at his desk for conferences; for those students who availed themselves of this opportunity, the conferences also provided direction both for revising as well as eliciting revising.

Another teacher used literature as a springboard for writing. After analysing some technical aspect of a story studied in the literature component of the class (such as characterization or the creation of mood), students were encouraged to experiment using techniques they had observed in their own writing. This was not precisely imitation since students were given a great deal of latitude. However, the criteria that emerged in critical discussions of literature were at play in their discussions of their own texts. Classroom pedagogy and organization, however, in both these classes was that of the process approach.

A third teacher developed an interesting adaptation of the de Bono thinking skills program as an extension of the process approach. Specifically, she spent some time developing such de Bono thinking strategies as considering all factors (CAF) or testing the PMI, i.e., the positive (plus), negative (minus), and interesting aspects of any topic. (See Appendix D.3.) She illustrated how such strategies can be used at the generating stage, especially in an argument. She also encouraged the students to use such generating strategies in groups, extending Graves' notions of prewriting conferences. In addition, the writing was used as a preparation for a debate. Since, debates were to be judged on a team basis, all members of the team had a vested interest in ensuring that each team member's argument was cogent and comprehensive. Consequently, revision was elicited with considerable vigour. This particular extension of the process approach was successful with advanced, general, and enriched students.

Alternate Pedagogies

As suggested earlier, the instruction in several other classes was clearly removed in essential ways from a process approach. In one class, the instructor chose to focus very directly on literature, using the traditional justification that it is only by contact with the finest pieces produced in our language that students will acquire the ability to write well. Although the class was intended as a writing class, the primary focus was on the analysis of works of literature. As we saw in the preceding section, such an emphasis is not necessarily at variance with a process approach. In this case,

however, composition pedagogy was of a very traditional kind. That is, the teacher talked about writing, rather than eliciting a complete process in her class; she defined what makes a good piece, based on the literature studied as well as on traditional dicta concerning good student writing. Writing itself was typically done out of class.

A second teacher responded in much the same way, without using literature as a prop. Although the teacher saw herself as teaching writing as process, the reality was that the classroom was conducted like a lecture-cum-discussion, with the teacher firmly centre-stage. The focus of class discussion was on writing; however, writing was quickly reduced to editing and especially grammar rules. While paying lip-service to the process approach, this teacher continually revealed her own discomfort at giving up control. In the end, all the class writing was done out of class, with the students using whatever strategies they had discovered on their own over the years.

Codifying the Process Approach

In 1983, Donald Graves began warning against the systemization of the process approach to the teaching of writing, and two of the teachers in our study clearly displayed this tendency. The point is that what Graves has argued for is an approach, not a lock-step methodology -- a way of encouraging students to engage in a complete process in the classroom, allowing teachers to intervene sensitively at crucial junctures. Some structure is necessary of course, to provide students with a framework to guide their independent work: we have several instances of such guidelines in the preceding pages. In

some cases, however, the structure is specified to such a degree that the essential spirit of the approach is destroyed. This is what happened in the classes of two of the teachers observed.

The classes were like workshops in that students were all involved in writing throughout the entire period. However, the instructions were so elaborate and carefully specified that students spent all their time checking off requirements and trying to complete what was expected of them, without ever becoming engaged by the writing itself. There was almost no conferencing -- with peers or with the teacher -- either before or after the writing of any draft. The instructions did include carefully specified forms for writing partners to fill in, presumably as part of a conference. However, either because they were unfamiliar with conferencing or because they felt they had no time, most students chose instead simply to pass on their pieces to be read in silence and commented on, in writing, according to the specified categories. Except that the writing was produced in class (and this too was a rule that was too rigidly adhered to), these classes did not <u>feel</u> like process classes: students were not engaged in their writing, there was no real sharing and appreciation of their peers' work, the teacher did not intervene to validate or redirect. The instructions were, in fact, consistent with a process approach, but in the end, rather than facilitating, they impeded and distorted the pedagogy.

<u>Changing Pedagogies</u>

Two teachers, in particular, showed a marked change in pedagogy over the year. In one case, a teacher quite deliberately moved away

from a very conventional pedagogy and began to explore aspects of the process approach. After establishing the tone and guidelines of a conventional composition class, she made her first tentative steps towards a process approach by modelling her own processes and eliciting student discussion about the choices implied and the possibilities for revision. Soon, she began circulating about the class to discuss pieces in progress, and then to encourage students to engage in the same kinds of discussions themselves. By the end of the year, the atmosphere in the class had altered dramatically from the prescriptive, teacher-centred focus of the beginning to a student-centred, process approach at the end.

A second teacher reinfused a rigidified approach with the Graves spirit. Some time in the middle of the year, he engaged the students in a piece of writing that was to have an end outside the writing class. Students were encouraged to work in groups, and the teacher suggested a variety of generating strategies that could be called on by the group as a whole or individually. In addition, each group was given public responsibility for the pieces of each of its members. Consequently, real revision was elicited. A class whose pedagogy seemed a lifeless mockery of the process approach became animated with its original spirit.

Classifying the Teachers

Of the eleven teachers who finally participated in the study, seven will be classified as "process" teachers: the six described in the section on process classes and the one whose pedagogy gradually changed to a process approach over the year. The remaining four

constitute a distinctly separate group in terms of pedagogy, and will be investigated as such in the analysis. These will be referred to as exemplars of "alternate pedagogies". In addition, within this latter group of four, one teacher changed his pedagogy at a clearly specified moment of time; we will compare the writing of his students before and after the new process-oriented pedagogy was in place.

CHAPTER FIVE: COMPUTER FACILITIES

The computer facilities differed among the various classes observed in this study. The type of computer, the software in use, the number of computers available, and their relative accessibility all varied from class to class. In the following sections, a precise description of the word processing facilities for each class or set of classes will be presented.

Grade 8 Class A

The computers were placed in a classroom adjacent to, but separate from the regular classroom. The lab contained sixteen Commodore computers and two printers. (Invariably, there was only one printer that worked at any one time.) Fourteen computers were arranged back to back in two rows on long tables. The two remaining computers were placed on smaller tables, one at the front of the room and one at the back. There was a considerable amount of space between computers, both on the tables and between the tables. This made moving to the printer as well as using pen and paper easy.

The writing teacher was also the computer teacher. She introduced the students to the word processing commands of the Textmaster software package in one or two sessions and posted the basic commands strategically around the lab.

During the writing classes, half the students were assigned to the computers according to a schedule. The teacher was able to

circulate in both rooms, intervening during the process whenever necessary.

Grade 8 Class B

Four Commodore computers and one printer were placed at one end of the regular classroom. There was a large conference table beside the computers in one corner and the teacher's desk in the other. Space between and around the computers was limited, but adequate.

The software program in use was PaperClip. The teacher was not himself familiar with either this computer or word processing in general. Guidance in word processing was offered by a student monitor, assigned to the class as part of his high school program.

The whole class was trained individually to use the word processing commands. After that, students were allowed to volunteer to write with the computer. In the end, only three or four students used the word processor regularly. Since, for the students writing by pen, considerable revising was done at home, those students who were working with a word processor were invited to use a computer lab at Carleton University over the weekends. These composing episodes were videotaped with a VCR.

Grade 12G and 12A Classes

All the 12G and 12A classes shared the same facility. Computers were placed in a separate room down the hall from the writing workshop. The computer room consisted of a glassed-in corner of an electrical appliance repair shop, large enough to hold five Apple IIe computers and one printer on two long tables. The tables were placed

at right angles to each other and computers were arranged so that the screens faced the center of the room.

The software program in use was Format II. One of the teachers was herself proficient at word processing; she composed extensively at home with the aid of a computer. She was the one who selected the software and provided the basic instruction in word processing with the aid of a monitor.

During the writing sessions, five students at a time were invited to use the computer room to compose specific pieces. In theory, every student was expected to take a regular turn with the computer, but in practice, several students at least avoided the computer lab after one session. The writing teachers remained in the classroom, while the computer lab, and the students writing there, were supervised by the computer monitor (and were observed by a member of the research team.)

Writing Class A

Sixteen ICON computers were placed in one half of a double-sized classroom in the basement. The second half consisted of a regularly set up classroom. About 25 per cent of the computer area contained equipment and was consequently walled off and placed out of bounds for students.

The computers were arranged back to back in four groups on long tables. There was ample table space beside each computer, but space between groups of computers was minimal; this made moving to the printer and intervention by instructors difficult.

Sometimes the writing teacher conducted his class in the double room, allowing those students who so wished to use the computer in the adjacent facilities. At other times, the writing teacher worked in his regular room upstairs with those writing by pen, while those volunteering to use the computer went to the computer facilities and worked there under the supervision of a member of the research team.

Instruction in word processing was given to the students by the computer teacher and was based on a manual intended for computer students, rather than those interested only in word processing. The program in use was the ICON text-editor.

Writing Class B

Sixteen ICON computers were situated in a separate classroom two floors up from the classroom where writing was normally done. The computers were arranged in two single rows on opposite sides of the room. There was adequate space between computers for ease of movement.

Instruction in word processing was given by a computer teacher and was augmented by the researcher. Again, it was the ICON text-editor that was in use for word processing. The whole class was given such instruction. After this initial exposure, however, students were allowed to volunteer to use the ICONs instead of writing by pen, and went to the computer room under the sole supervision of a member of the research team.

Supplementary Studies

As even this cursory description suggests, it was only in Grade 8 Class A that the circumstances of computer use were close to ideal. In other classrooms, the limited number of computers available and the necessary removal of students from the supervision of their writing teachers imposed severe limitations on composing with a computer. These, however, are the educational realities that writing teachers must confront and that, consequently, researchers into the effect of word processing use on composing must acknowledge. In other words, these are the circumstances in which many students will learn to write with a computer, and it is the combined effect of these circumstances and computer use that will need to be measured. Chapters Six and Seven describe the tools and results of such measurement.

At the same time, however, we also hoped to discover the effect of computer use on composing processes and products, without the confounding impact of these limiting educational realities. For this reason, two supplementary studies were undertaken in which the computer facilities were as close to the ideal as is possible in an educational setting. The precise description of the organization of these studies will be presented in Chapter Eight and the findings reported in Chapter Nine.

CHAPTER SIX: ANALYSES

Many kinds of data were amassed, and these were submitted to different kinds of analyses. Specifically, student compositions of three types were collected: pre-test essays, post-test essays, and a range of scripts composed by students throughout the year as part of their English or writing class assignment. (These will be referred to from here on as class essays or class compositions.) All these scripts were subjected to varying levels of analysis: analysis of the layers of revision between first and final draft; forced-choice quality ratings, comparing first and final drafts; evaluation of the scripts according to a set of precisely specified rhetorical criteria. These three kinds of analysis are described more precisely below.

In addition, the classroom observations produced different kinds of data. First, there were the videotape records of composing behaviours of individual students. Second, there were formal coding sheets, recording typical behaviours of a whole class during a writing session. These are both described below. And finally, there were the observational logs, which formed the underpinning of the descriptions of pedagogies in Chapters Four and Five, as well as some of the discussion in Chapters Eight, Ten, and Eleven.

Revision Analysis

As the description of the study's design in Chapter Three reveals, special provisions were made in both the pre-test and the post-test to allow students enough time away from and with their texts to revise at least once. Students were given two separate periods on different days for their actual composing (in addition to the time assigned for generating). On the first day, teachers announced that students were to write the first draft of their composition that day. They also explained that this draft would be collected at the end of the period and that some time later the draft would be returned to allow for revision and the preparation of a final copy. We tried thus to ensure that students would have enough time away from their first drafts to be able to look at their texts with fresh eyes; in addition, we wanted the students to know that their first attempt was to be a rough draft so that they would feel free to explore and write freely the first time around. The notion was that, if students had developed useful revision strategies in the past, such a time apportionment, although not ideal, would at least allow them to bring some of these strategies into play.

As to the texts composed throughout the year, the expectation was that teachers committed to a writing process approach would ensure that a significant number of compositions for each student would be subjected to revision. And certainly, despite the variation in composition pedagogy described in Chapter Four, there was at least that level of commonality to all the classes.

Revision analyses were performed on all the pre-tests, the post-tests, and the class essays. The instrument used to categorize and enumerate the revisions between first and last draft is included as Appendix B.1.

In general terms, the revision instrument aims at categorizing the types of changes according to the kind of revision operations as well as the level. The kinds of revision operations are four: addition, deletion, substitution, and reordering. These operations may take place at the following levels: word, phrase, sentence, idea unit (to consist of two or more sentences), section (a notion akin to the conceptual paragraph), and whole draft. For each paper, we counted the number of instances of each kind of operation at each level. On this basis, the computer was subsequently programmed to make the following calculations for each paper: total number of additions per 50 words; total number of deletions per 50 words; total number of substitutions per 50 words; total number of reorderings per 50 words; total number of changes at the word level per 50 words; total number of changes at the phrase level per 50 words; total number of changes at the sentence level per 50 words; total number of changes at the idea unit level per 50 words; total number of changes at the section level per 50 words; total number of all kind of changes per 50 words.

In addition, the revision analysis looked at whether an entirely new draft was attempted, a partial new draft, and whether there were any written prefigurings -- notes, outlines, etc.

Word Length

As part of the revision instrument, the number of words in the final copy of each script was counted. This was necessary in order to be able to compare the revisions in pieces of differing lengths. In addition, though, word length itself is an independent measure that can offer potentially interesting insights into the differences between the two conditions: writing with the aid of a pen as opposed to a word processor. Sometimes, length is associated with quality; at the very least, length is an indication of fluency. Consequently, the results of the word-length comparison are reported separately from the revision analyses.

Forced-Choice Quality Ratings

Two more direct methods of analysing quality were attempted. First, a subset of class compositions was selected for forced-choice comparisons with respect to revision. Class essays were selected for this analysis for two reasons. First, the intention was to compare pieces written on the computer with those written by pen, and it was only class compositions that were composed with a computer. Secondly, the pre- and post-tests were confined to two writing sessions; consequently, the opportunities for revising were limited, in comparison with what was possible in a class essay. Our goal in the forced-choice rating was to compare the first and last drafts of pieces which had been revised as extensively as their authors' intentions dictated.

To put it another way, for the forced-choice rating, our goal was to compare scripts in which significant changes had been made. The revision analyses, on the other hand, had been undertaken to reveal under which condition (pen or computer) more changes were made. The question to be addressed in the forced-choice evaluation, in contrast, was the following: when changes were made, were they more likely to be for the better when produced by pen or by computer? At the Grade 8 level, there were not enough computer-produced scripts with a significant number of changes to allow for comparisons. At the Grade 12 level, eight essays produced on the computer were selected; these all showed significant changes, with an average of 25 revisions per piece. (These, incidentally, were the only computer-produced scripts at that level with extensive changes.)

For comparison, two groups were selected. One consisted of ten significantly revised essays written by pen by students in the same computer classes; the second included ten essays written in a control class with a process orientation.

The method of analysis was as follows. Fresh copies of the first and final drafts of all selected pieces were typed using the same font for all pieces. The principal investigator numbered all pieces randomly, using a secret code to indicate, after the comparisons, whether the texts were first or later drafts, and whether they were written by pen or computer. Two research associates made forced-choice comparisons between the first and last draft for each set of papers; the choice was made solely on the basis of a holistic impression of quality. Inter-rater reliability was later calculated, and performance in the two conditions was compared.

Rhetorical Analysis

A further kind of analysis was performed in order to determine the relative quality of pieces written by pen as opposed to those written by computer as well as to define the nature of these qualititative differences. Specifically, an instrument was used that specified a set of rhetorical criteria according to which each text was to be rated. Such criteria included the following: unity; organization; development (the degree of elaboration); register (or appropriateness of tone); overall style; sentence structure; range of vocabulary; vividness; economy; reader awareness.

Each criterion was rated according to a ten-point scale. For a precise description of the different gradations on each scale, see Appendix B.2. Two raters rated each piece. Where there was a discrepancy of more than one point, they discussed the issue until they came to an agreement. Statistical comparisons were calculated on the basis of the final agreed-on ratings.

The selection of pieces for such rhetorical analysis was made on the following basis. First, our primary goal was to compare the effect of the two conditions on writing quality. Consequently, we focused primarily on classes where the same students wrote both by pen and on computer. In addition, we controlled for mode, looking only at the writing of arguments. At the Grade 8 level, the compositions of fifteen students were compared for a total of thirty pieces. At the Grade 12 level, twenty-four pieces were analysed. In addition, as the discussion in Chapter Eight will reveal, similar kinds of rhetorical comparisons were made for two groups of students involved in the supplementary studies. In the end, ninety-nine

scripts were analysed in this way.

Videotape Recordings

As described in Chapter Three, a different way of analysing revision and composing strategies was sought by employing a VCR to record what was occurring on-screen as students composed with the aid of a computer. The only computer that allowed for the easy attachment of a video recording machine was the Commodore, and only two of the classes in the study used this type of computer. Fortunately, these happened to be classes in which both the pedagogy and computer facilities were close to ideal. Consequently, the VCR data is particularly valuable.

In order to acquire some data for other classes, volunteers were enlisted to come to a Carleton University computer laboratory facility on weekends in order to compose their class essays there. In this way, we were able to obtain some supplementary data for two other classes.

In order to analyse the data offered by the video recordings, transcriptions were made of everything that occurred on screen. Analyses were performed from two perspectives. First, the nature and level of the revisions occurring during the first draft were determined. These, of course, could not be captured in our first-draft-to-final-draft revision analyses. Such within-draft revisions on the computer were then compared with the revisions made by pen during the composing of their first drafts by the same students. (Revisions by pen of course left an indelible record on the drafts themselves.) In addition, the video records left us with further

evidence of composing behaviours, both during the first draft as well as in later revisions.

Classroom Observations

One dimension of the study involved comparing what went on in a class as a whole during writing sessions for each of the two conditions. In order to compare the classroom behaviours of students writing with a computer with those writing by pen, a coding sheet was developed incorporating the range of possible activities as suggested by our observations. Such activities included the following: talks to friend; plays (e.g. doodles); conferences with teacher; pauses (sits, thinking and staring); composes; recopies or retypes previous draft; formats; rereads draft or printout; rereads computer screen; revises draft or printout; revises on screen; reads draft aloud in conference; listens to partner's draft read aloud; discusses draft in conference; asks/tells how to spell; asks/tells how to use computer command; uses reference; works at printer; other. A sample codesheet is included as Appendix B.3.

In order to code students' behaviours, the researcher stood at the side of the classroom and recorded students' behaviours in a fixed order during five second intervals according to one of the pre-selected categories. When everyone's writing behaviour had been recorded, the process was repeated throughout the entire writing session. Procedures were identical whether students were writing by pen or computer except that in the computer class it was necessary for the researcher to move around the room much more.

This kind of analysis was performed with regularity on two classes in particular. These two were selected for comparison for a number of reasons. First, the computer class selected was the only one in which the entire class was given the opportunity to compose on the computer at the same time. In all the other classes where the computer was introduced, limited numbers of students composed on the computer, while the rest wrote by pen. In addition, this class was the one in which both the writing pedagogy and the computer facilities were close to ideal. Students were given extensive opportunities to write, a complete writing process was typically elicited, and the computer was user friendly, bug-free, and always accessible. For comparison, a writing class was selected in which the pedagogy was as similar as possible to that of the computer class.

CHAPTER SEVEN: FINDINGS

Revision Analysis

Statistical Procedures. All the revision codesheets were entered first on tape, then onto the computer. Subsequently, a variety of statistical manipulations were performed using the Statistical Package for the Social Sciences.

Pen vs. Computer Differences. All the writing was classified with respect to its mode of production. Scripts were either written entirely on the computer, from first draft to last draft; entirely by pen, from first draft to last draft; first draft by pen and last draft on the computer; first draft on the computer and last draft by pen. There were very few scripts in the last category; most of the compositions fell into the first two categories, and for each of the revision categories, one-way analyses of variance were performed using pen vs. computer as the independent variable. Only class essays were compared, since it was only in such writing, that the conditions for composing were comparable.

Tables 7.1, 7.2, and 7.3 summarize the results for each of the grade levels. Only those results that were statistically significant are reported here. What is striking about these results is that, almost universally, there are more changes, of all kinds, and at all levels, in the essays written entirely by pen. (It should be noted that the tendency in those results that were not statistically

significant was all in the same direction.) There are two exceptions: changes at the section level for 12A students where the numbers are in any event very small; and numbers of drafts in the 12A compositions. This latter in fact is particularly revealing. Even though the 12A students wrote more drafts on average on the computer, they made fewer revisions.

TABLE 7.1: COMPARISON OF REVISIONS PER 50 WORDS IN CLASS ESSAYS OF GRADE 8 STUDENTS: PEN VS. COMPUTER

	Pen (n=55)		Computer (n=30)			
	Mean	S.D.	Mean	S.D.	F	p
Total Additions	1.63	1.07	.23	.28	49.89	.0000
Total Deletions	1.15	.88	.09	.18	41.98	.0000
Total Reorderings	.12	.17	.00	.00	15.70	.0002
Total Substitutions	1.41	.86	.17	.29	58.27	.0000
Total Changes	4.31	2.31	.49	.58	79.42	.0000
Changes at Word Level	1.91	1.11	.11	.19	77.23	.0000
Changes at Phrase Level	1.51	.93	.17	.26	59.02	.0000
Changes at Sentence Level	.78	.79	.12	.25	19.96	.0000

TABLE 7.2: COMPARISON OF NUMBER OF DRAFTS AND REVISIONS PER 50 WORDS IN CLASS ESSAYS OF GRADE 12G STUDENTS: PEN VS. COMPUTER

	Pen (n=65)		Computer (n=10)			
	Mean	S.D.	Mean	S.D.	F	p
No. of Drafts	1.89	.73	1.40	.97	3.60	.0619
Total Additions	.76	.88	.09	.20	5.62	.0204
Total Deletions	.60	.63	.13	.40	5.21	.0254
Total Substitutions	.96	1.10	.00	.00	7.55	.0076
Total Changes	2.45	2.35	.26	.66	8.49	.0047
Changes at Word Level	1.24	1.31	.17	.53	6.50	.0129
Changes at Phrase Level	.79	.91	.03	.08	6.95	.0102

TABLE 7.3: COMPARISON OF NUMBER OF DRAFTS AND REVISIONS PER 50 WORDS IN CLASS ESSAYS OF GRADE 12A STUDENTS: PEN VS. COMPUTER

	Pen (n=206)		Computer (n=51)			
	Mean	S.D.	Mean	S.D.	F	p
No. of Drafts	1.16	.95	2.98	1.84	20.04	.0000
Total Additions	.65	.68	.23	.29	17.92	.0000
Total Deletions	.46	.53	.12	.18	21.31	.0000
Total Reorderings	.12	.19	.04	.08	8.78	.0033
Total Substitutions	.95	.97	.30	.41	22.07	.0000
Total Changes	2.18	2.04	.69	.74	26.45	.0000
Changes at Word Level	1.03	1.03	.26	.36	27.12	.0000
Changes at Phrase Level	.81	.88	.23	.31	21.83	.0000
Changes at Sentence Level	.27	.38	.13	.18	7.08	.0083
Changes at Section Level	.01	.05	.04	.06	13.63	.0003

Analyses of variance were also performed on the writing at each level by mode of writing. That is, arguments were treated separately, as were narratives. Tables C.1 - C.6 in Appendix C summarize the results that were statistically significant. It is sufficient to note that differentiation by mode produced the same results: students revised more extensively by pen.

Pen vs. Computer vs. Pen/Computer. Further analyses of variance were performed on the same data using a further differentiation in the conditions of writing. Essays for which first drafts were composed by pen and later drafts on the computer were compared to those written entirely by pen and those entirely by computer. Tables 7.4, 7.5, and 7.6 summarize these results.

TABLE 7.4: COMPARISION OF NUMBER OF DRAFTS AND REVISIONS PER 50 WORDS IN CLASS ESSAYS OF GRADE 8 STUDENTS: PEN VS. COMPUTER VS. PEN/COMPUTER

	Pen (n=55)		Computer (n=30)		Pen/Computer (n=24)			
	Mean	S.D.	Mean	S.D.	Mean	S.D.	F	p
No. of Drafts	2.36	.68	2.13	.82	3.04	.36	13.29	.0000
Total Additions	1.63	1.07	.23	.28	1.09	.72	26.84	.0000
Total Deletions	1.15	.88	.09	.18	.55	.39	25.84	.0000
Total Reorderings	.12	.17	.00	.00	.10	.14	8.10	.0005
Total Substitutions	1.41	.86	.17	.29	1.33	.99	26.19	.0000
Total Changes	4.31	2.31	.49	.58	3.06	1.84	40.20	.0000
Changes at Word Level	1.91	1.11	.11	.19	1.58	1.14	35.10	.0000
Changes at Phrase Level	1.51	.94	.17	.26	.97	.60	32.32	.0000
Changes at Sentence Level	.78	.79	.12	.25	.45	.36	12.00	.0000

TABLE 7.5: COMPARISON OF NUMBER OF DRAFTS AND REVISIONS PER 50 WORDS IN CLASS ESSAYS OF GRADE 12G STUDENTS: PEN VS. COMPUTER VS. PEN/COMPUTER

	Pen (n=65)		Computer (n=10)		Pen/Computer (n=5)			
	Mean	S.D.	Mean	S.D.	Mean	S.D.	F	p
No. of Drafts	1.89	.73	1.40	.97	2.40	.55	3.20	.0464
Total Additions	.76	.88	.09	.20	.92	.87	3.01	.0552
Total Substitutions	.96	1.10	.00	.00	1.36	.55	4.56	.0134
Total Changes	2.45	2.35	.26	.66	2.99	.84	4.79	.0110
Changes at Word Level	1.24	1.31	.17	.53	1.52	.45	3.69	.0295
Changes at Phrase Level	.79	.91	.03	.08	.60	.21	3.68	.0298
Changes at Section Level	.01	.03	.03	.08	.08	.11	4.67	.0122

TABLE 7.6: COMPARISON OF NUMBERS OF DRAFTS AND REVISIONS PER 50 WORDS IN CLASS WRITING OF GRADE 12A STUDENTS: PEN VS. COMPUTER VS. PEN/COMPUTER

	Pen (n=206)		Computer (n=51)		Pen/Computer (n=17)			
	Mean	S.D.	Mean	S.D.	Mean	S.D.	F	p
No. of Drafts	2.16	.95	2.98	1.84	3.35	1.90	14.76	.0000
Total Additions	.65	.68	.23	.29	.66	.58	9.21	.0001
Total Deletions	.46	.53	.12	.18	.33	.42	10.94	.0000
Total Reorderings	.12	.19	.04	.08	.13	.16	4.67	.0102
Total Substitutions	.95	.97	.30	.41	.71	.68	11.44	.0000
Total Changes	2.18	2.04	.69	.74	1.83	1.67	13.39	.0000
Changes at Word Level	1.03	1.03	.26	.36	.85	.79	13.80	.0000
Changes at Phrase Level	.81	.88	.23	.31	.69	.66	11.13	.0000
Changes at Sentence Level	.27	.38	.13	.18	.24	.38	3.51	.0313
Changes at Section Level	.01	.05	.04	.06	.01	.06	6.73	.0014

The number of pieces begun by pen and revised on the computer is not great. Nevertheless, as suggested in these tables, far more revisions occur in this condition than when the piece is written entirely on the computer. Although, on the whole, there are still more revisions when the piece is written entirely by pen, most of these differences are not statistically significant. And at the 12G level, more revisions are made in the pen/computer condition than by

pen alone. Unfortunately, in this case, the numbers are so small that all they can point to is the need for more extensive testing.

To sum up then, statistical analyses of the number and kinds of revisions reveal that there are more changes made to essays written entirely by pen.

Revisions by Teacher. Given the kind of information garnered in the observational analyses about differences in pedagogy, it was interesting to compare the number and kind of revisions in the compositions by teacher. Table 7.7 summarizes the findings concerning the mean number of revisions per 50 words in all the scripts, as categorized by teacher.

Simply scanning the data suggests certain patterns. The column referring to the total number of revisions per 50 words (Total Changes) reveals that in the classes of some teachers, students were making close to three or four changes per 50 words, and in the classes of others, the number hovered below or close to two. On the basis of the total number of changes as well as grade level, we classified the teachers into three groups. Group One consists of four teachers from Grade 8. Group Two includes three teachers at the senior level; the courses taught by these three involve the whole spectrum -- 12G English, 12A English, and a writing course. Group Three consists of the same mix of Grade 12 teachers and courses as Group Two.

TABLE 7.7: COMPARISON OF MEAN NUMBER OF REVISIONS PER 50 WORDS IN ALL SCRIPTS, CATEGORIZED BY TEACHER

(Standard Deviation in Parenthesis Below the Mean)

	Total Additions	Total Deletions	Total Reorderings	Total Substitutions	Total Changes	
Grade 8 Teacher A (n=93)	1.372 (.926)	1.023 (.916)	.118 (.179)	1.465 (1.00)	3.977 (2.395)	
Grade 8 Teacher B (n=59)	.852 (.750)	.569 (.542)	.085 (.127)	.847 (.739)	2.352 (1.732)	Group One
Grade 8 Teacher C (n=39)	1.240 (1.384)	.653 (.663)	.135 (.237)	.943 (.939)	2.970 (2.561)	
Grade 8 Teacher D (n=94)	.899 (.874)	.692 (.770)	.100 (.203)	1.113 (1.051)	2.803 (2.335)	
Grade 12G Teacher E (n=75)	.986 (.813)	.628 (.519)	.158 (.263)	1.299 (.967)	3.071 (1.933)	
Writing Course Teacher F (n=96)	.806 (.697)	.611 (.600)	.101 (.150)	1.063 (.910)	2.580 (1.966)	Group Two
Grade 12A Teacher G (n=82)	.910 (.675)	.695 (.534)	.115 (.143)	1.409 (.953)	3.128 (1.955)	
Grade 12A and G Teacher H (n=178)	.520 (.629)	.375 (.514)	.078 (.135)	.715 (.864)	1.689 (1.838)	
Writing Course Teacher I (n=57)	.730 (.784)	.578 (.692)	.085 (.139)	.893 (.929)	2.227 (2.258)	Group Three
Grades 12A and G Teacher J (n=147)	.501 (.694)	.357 (.581)	.062 (.140)	.595 (.826)	1.514 (1.872)	
Writing Course Teacher K (n=97)	.682 (.719)	.423 (.537)	.131 (.218)	.829 (.848)	2.065 (2.020)	

TABLE 7.8: ANALYSIS OF VARIANCE ON MEAN NUMBER OF REVISIONS PER 50 WORDS IN CLASS ESSAYS CATEGORIZED BY TEACHER GROUP

	Group Three		Groups One and Two			
	Mean (n=199)	S.D.	Mean (n=223)	S.D.	F	p
Sums per 50 words:						
Additions	.47	.67	1.01	.89	48.35	.0000
Deletions	.31	.49	.71	.67	45.97	.0000
Reorderings	.08	.17	.13	.21	5.77	.0167
Substitutions	.57	.86	1.21	.97	50.94	.0000
Total Changes Per 50 Words:	1.44	1.90	3.06	2.21	64.49	.0000
Changes by Levels Per 50 Words:						
Word	.71	1.02	1.41	1.12	45.09	.0000
Phrase	.48	.73	1.09	.91	56.46	.0000
Sentence	.20	.40	.46	.58	26.89	.0000
Idea	.03	.09	.07	.15	13.73	.0002
Section	.01	.04	.02	.05	1.21	.2717

Calculation of the means for the three groups reveals that, in Groups One and Two, students make just under three revision per 50 words each (3.0 for Group One and 2.9 for Group Two), and in Group Three, students make just under two revisions per 50 words (1.9). Table 7.8 presents the results of an analysis of the variance on the mean number of revisions per 50 words in the scripts classified by Teacher Group.

What is interesting is that Group One and Group Two teachers were all process teachers, as categorized in Chapter Two. The teachers in Group Three all practised alternate composition pedagogies. That there was no significant difference by grade level remains a puzzle. Pedagogy, however, seemed to exert a considerable influence on writing performance.

Pre-test vs. Post-test Difference. Unfortunately, as indicated in Chapter Three describing the design, post-tests were not performed in the classes of five teachers. Three of these included teachers in Group Three (as described in the preceding section). And four of the five taught computer classes. Consequently, no useful overall comparisons can be made -- either with respect to composition pedagogy or computer-based pedagogy -- on the basis of examining post-test vs. pre-test results.

Certain limited comparisons, however, were possible and proved to be illuminating. When one-way analyses of variance were performed investigating the differences between pre-tests and post-tests for specific matched classes, two Grade 8 classes showed interestingly different results. In the class of Teacher A there were significantly more revisions in the post-test. See Table 7.9 for a summary of these differences. In contrast, Teacher D's class showed no significant differences between pre- and post-tests. What differentiated these two classes was not the writing pedagogy (the teachers shared the same process approach), but the fact that Teacher D used the computer as a writing tool for most of the year for her whole class.

TABLE 7.9: COMPARISON OF MEAN NUMBERS OF REVISIONS PER 50 WORDS ON POST-TEST VS. PRE-TEST FOR GRADE 8 TEACHER A

	Pre-Test (n=24)	Post-Test (n=23)	F	p
Total Reorderings	.05	.21	10.16	.0026
Total Substitutions	1.16	2.02	6.72	.0128
Total Changes	2.73	4.47	6.15	.0169
Changes at Word Level	1.15	2.27	9.81	.0031
Changes at Idea Level	.01	.09	7.64	.0083

Pre-tests and Post-tests vs. Class Essays. A different kind of comparison was equally revealing. Analyses of variance were performed comparing revisions on the test essays with those on the class essays. Given the severe time limitations placed on the test essays (only two periods of writing for each), one would *a priori* have assumed that the class compositions would have been subjected to far more revision.

Table 7.10 summarizes the statistically significant results for the Grade 8 classes. (Note that for Teachers B and C, it is only the pre-tests that are included in the test category; consequently, it is the difference between Teachers A and D that are most significant.) For Teacher A, as well as for Teachers B and C, there are significantly more revisions made in the class essays. Only for Teacher D, whose class essays were written primarily on the computer, were the differences in the counter-intuitive direction. That is, there were more changes in the test essays.

TABLE 7.10: COMPARISON OF MEAN NUMBER OF REVISIONS PER 50 WORDS FOR TEST ESSAYS VS. CLASS ESSAYS IN GRADE 8 CLASSES

	Test Essays	Class Essays	F	p
Teacher A	n=47	n=46		
Total Additions	1.05	1.70	13.19	.0005
Total Deletions	.83	1.22	4.44	.0379
Changes at Sentence Level	.44	.84	6.65	.0115
Changes at Section Level	.00	.02	4.58	.0350
Teacher B	n=52	n=7		
Total Additions	.78	1.40	4.42	.0400
Total Deletions	.51	1.01	5.70	.0203
Total Substitutions	.76	1.52	7.27	.0092
Total Changes	2.13	4.04	8.46	.0052
Changes at Word Level	.86	1.95	13.55	.0005
Changes at Phrase Level	.78	1.47	5.33	.0247
Teacher C	n=32	n=7		
Total Substitutions	.80	1.60	4.64	.0377
Changes at Idea Level	.02	.10	3.99	.0533
Teacher D	n=52	n=42		
Total Additions	1.10	.65	6.62	.0117
Total Deletions	1.01	.30	24.58	.0000
Total Reorderings	.14	.05	4.55	.0355
Total Substitutions	1.44	.71	12.55	.0006
Total Changes	3.69	1.71	20.08	.0000
Changes at Word Level	1.56	.78	10.79	.0014
Changes at Phrase Level	1.52	.55	22.83	.0000
Changes at Sentence Level	.55	.30	4.58	.0349
Changes at Section Level	.00	.02	4.79	.0312

An examination of specific Grade 12 classes is even more startling. See Table 7.11. The important point to note is that for Teachers H, J, and K, the tests are the pre-tests. In each of these classes, there are more revisions in the pre-tests than in the class essays. In other words, students actually made more changes at the beginning of the year, before any writing instruction, in the context of a controlled writing situation, than they were making under the

influence of their teachers' direction. Two separate factors may account for this. All three classes involved some use of the computer for class writing. That is, some students used the computer to write, some of the time. In addition, all three teachers were practitioners of alternate composition pedagogies.

TABLE 7.11: COMPARISON OF MEAN NUMBER OF REVISIONS PER 50 WORDS FOR TEST ESSAYS VS. CLASS ESSAYS IN GRADE 12 CLASSES

	Test Essays	Class Essays	F	p
Teacher H	n=105	n=73		
Total Reorderings	.10	.05	5.62	.0189
Total Substitutions	.83	.54	5.04	.0260
Total Changes	1.95	1.32	5.24	.0233
Changes at Phrase Level	.73	.47	5.01	.0264
Changes at Sentence Level	.32	.19	4.06	.0455
Changes at Idea Level	.12	.02	15.08	.0001
Teacher J				
Total Substitutions	.70	.36	5.12	.0251
Changes at Phrase Level	.56	.33	3.34	.0699
Teacher K				
Total Additions	1.16	.53	16.35	.0001
Total Deletions	.71	.33	9.95	.0022
Total Changes	2.93	1.78	6.21	.0144
Changes at Phrase Level	1.24	.64	8.58	.0042
Changes at Sentence Level	.75	.23	18.72	.0000
Teacher F	n=53	n=43		
Total Reordering	.06	.15	8.51	.0044
Changes at Word Level	.95	1.32	3.69	.0579
Changes at Idea Level	.04	.10	4.57	.0351

The contrasting case is that of Teacher F, a committed process teacher. The results from the revision analysis of his class shows a statistically significant change in the direction of more revisions in the class essays on several variables (and the tendency on other

variables is in the same direction). Teacher F's class was also one where all the writing was by pen.

The findings for the two other process teachers at the senior level are somewhat more ambiguous. For Teachers E and G, there are no statistically significant differences between test and class essays. This may be explained by the fact that the mean number of changes for these teachers is much higher than for Teachers J, H, and K (and indeed higher than that of Teacher F), and consequently a kind of ceiling effect may have been reached.

To sum up, in the classes of four teachers, students made fewer changes in the class essays than in the test essays. One class was a Grade Eight class, whose teacher was a committed process teacher; however, most of the class essays had been composed on the computer. The other three were Grade Twelve classes, whose class essays were sometimes composed on the computer, and whose teachers were proponents of alternate composition pedagogies. The results of these latter three are particularly revealing, since the test essays consisted entirely of pre-tests. What is suggested here is that the kinds of directions provided for the test essays were more effective than classroom instruction for eliciting change. Given the potential range of strategies and resources in the classroom, this result is astonishing.

Summary. The results of the revision analysis revealed the following.

1. There were more changes in essays written entirely by pen than in those written on the computer for all grade levels.

2. Essays that were begun by pen and revised on the computer revealed more revisions than those written entirely on the computer. The number of revisions in such essays approached that in essays written by pen.

3. There was variation by teacher, not by grade level, in the number of revisions performed on all scripts. Specifically, one group of Grade 12 teachers was distinguished by the fact that writing produced in these classes showed fewer revisions than writing produced either in the classes of the other three Grade 12 teachers or in the Grade 8 classes. These teachers were identified in Chapter Four as those exemplifying alternate approaches to composition pedagogy.

4. Differences between post-tests and pre-tests for two Grade 8 classes showed that the class in which the computer was used made no gains, while the class that wrote by pen showed considerable growth. Composing pedagogy in both classes was comparable.

5. Comparisons of the test essays vs. class essays revealed that, in some classes, there were fewer changes in class essays, despite the more extensive time period and more facilitative environment potentially afforded such essays. This counter-intuitive finding was accounted for, in some cases, by the use of the computer in the class essays, in others, by more limited writing pedagogy in class, or a combination of both.

Word Length

In addition to analysing the number of revisions per 50 words of text, the length of each composition, in terms of number of words,

was calculated. Comparisons were then made between those class essays produced on the computer and those produced by pen. (Test essays were not included because the conditions under which they were written were so different.) Specifically, a one-way analysis of variance was performed on the class essays by grade level, using condition of writing (pen vs. computer) as the independent variable. Table 7.12 summarizes the findings.

TABLE 7.12: WORD LENGTH OF CLASS ESSAYS IN GRADES 8, 12G, 12A: PEN VS. COMPUTER

	Pen		Computer			
	Mean	S.D.	Mean	S.D.	F	p
Grade 8	376.64	270.53	269.40	187.83	3.72	.05
Grade 12G	305.10	166.74	181.78	114.60	4.50	.04
Grade 12A	424.40	201.69	732.84	504.79	44.15	.00

For Grades 8 and 12G, students wrote significantly more by pen. In 12A, it was the students writing with the aid of the computer who wrote longer pieces. The results with respect to word length are mixed. At the 12A level, at least for some students, the computer does encourage greater fluency. However, at the Grade 8 and Grade 12G levels, students are far more fluent writing by pen.

Forced-Choice Quality Rating

In addition to determining differences in the number and kind of revisions in essays produced under the two conditions, we were interested to discover the degree to which revisions improved the final draft. For that reason, first and last drafts of class essays in which there were significant revisions were compared. Specifically, a total of thirty Grade 12 pieces were compared: ten computer produced pieces with significant revisions (the only ten at that level with significant revisions) were compared with a set of ten-handwritten pieces, in the same mode, produced in the same composition classes, as well as with a set of ten handwritten pieces produced in a process class where all writing was performed by pen.

First and final drafts of each paper were compared holistically by two separate raters. The two raters agreed on 85% of the papers. When the scores were averaged, between 60 and 70% of the papers in each set were rated as having been improved by the revisions. In other words, revisions by computer and by pen led to improvement in the essays in a majority of the cases, and there was no difference as to the condition. Students were as likely to improve their essay revising by pen as they were revising by computer.

Rhetorical Analysis

A different attempt to look at quality was undertaken. Rather than analysing differences in quality achieved through revision, the rhetorical analysis was aimed at discovering whether the two conditions led to differences in the quality of the final product. Ten separate criteria were employed in this evaluation, each with a

clearly defined ten-point scale. The mode was controlled and only arguments were analysed. Further, at both the Grade 8 and the Grade 12 level, the scripts analysed involved pen and computer productions by the same students.

Two separate raters undertook the evaluation and they reached agreement on average in 73% of their judgements. (See Table 7.13 for a precise breakdown of their agreement by criterion.) Where the raters were apart by more than one point, they reanalysed the piece and came to a new joint decision. It is this latter score that was used in the calculations.

TABLE 7.13: PERCENTAGE OF INTER-RATER AGREEMENT ON EACH OF THE QUALITATIVE MEASURES CATEGORIES

Unity	65.66
Organization	68.69
Development	66.67
Register	68.69
Overall Style	75.76
Sentence Structure	72.73
Range of Vocabulary	81.82
Vividness	76.77
Economy	76.77
Reader Awareness	75.76

Two-tailed *t*-tests were run on the difference of the means between the two conditions for each of the criteria, by grade level. Tables 7.14 and 7.15 summarize the results. The only statistically significant differences were on the degree of unity for the Grade 8 essays and on the degree of economy for the Grade 12 essays. In both cases, the differences were in favour of the pen condition. Furthermore, the tendency on all the other criteria was in the same direction: as measured according to rhetorical criteria, the pieces produced by pen were judged to be superior.

TABLE 7.14: T-TESTS ON RHETORICAL ANALYSES OF ARGUMENTATIVE ESSAYS AT THE GRADE 8 LEVEL

	Essays by Pen (n=15)		Essays by Computer (n=15)		
Criteria:	M	S.D.	M	S.D.	t
Unity	3.2	1.37	2.4	.67	2.60*
Organization	2.9	1.15	2.5	.72	1.59
Development	2.7	1.27	2.6	.66	.37
Register	2.9	1.06	2.7	.64	1.01
Overall Stylistic Effectiveness	3.1	1.52	2.7	.69	1.40
Sentence Structure	3.2	1.24	3.0	.66	.77
Range of Vocabulary	3.2	1.24	2.9	.67	1.14
Vividness	2.8	1.45	2.4	.55	1.27
Economy	2.9	1.39	2.6	.62	1.30
Reader Awareness	3.1	1.26	2.8	.88	1.28

*$p > .05$

TABLE 7.15: T-TESTS ON RHETORICAL ANALYSES OF ARGUMENTATIVE ESSAYS AT GRADE 12 LEVEL (WRITING COURSE)

	Essays by Pen (n=16)		Essays by Computer (n=8)		
Criteria:					
	M	S.D.	M	S.D.	t
Unity	4.6	1.56	3.8	1.71	1.67
Organization	4.4	1.54	3.5	1.73	1.89
Development	4.3	1.04	3.8	1.84	1.17
Register	5.2	1.19	5.2	1.59	.10
Overall Stylistic Effectiveness	4.5	1.06	4.4	1.17	.26
Sentence Structure	4.6	1.19	4.4	1.54	.61
Range of Vocabulary	5.2	1.02	5.1	1.43	.42
Vividness	3.4	1.06	3.4	.70	.20
Economy	4.8	1.26	3.6	1.27	3.16**
Reader Awareness	5.0	1.20	4.8	1.20	.67

**p > .01

High vs. Low Achievers

As we have seen in Chapter Two, the research literature suggests that computer use may particularly advantage low-achieving students. For that reason, we were interested in comparing the relative performance of high-achieving and low-achieving students, specifically with respect to quality ratings. It was only among the Grade 8 students that differences in ability were significant and clear-cut,

and that written productions were comparable. Table 7.16 consequently compares the performance of students of different ability levels at the Grade 8 level.

TABLE 7.16: COMPARISON OF LOW- AND HIGH-ACHIEVERS ON PERFORMANCE, BY CONDITION, FOR RHETORICAL CRITERIA

	Low (n=12)			High (n=18)		
	Pen	Computer	t	Pen	Computer	t
	M	M		M	M	
Unity	2.5	2.0	1.48	3.6	2.7	2.40*
Organization	2.3	2.2	.51	3.3	2.8	1.74
Development	1.9	2.0	.32	3.2	3.0	.67
Register	2.7	2.4	.79	3.1	2.9	.71
Overall Style	2.4	2.3	.28	3.6	2.9	1.52
Sentence Structure	2.7	2.8	.22	3.5	3.1	1.16
Vocabulary Range	2.7	2.5	.46	3.5	3.1	1.16
Vividness	2.2	2.2	.00	3.2	2.6	1.44
Economy	2.8	2.3	1.16	3.1	2.8	.75
Reader Awareness	2.8	2.3	1.10	3.4	3.1	.87

*$p < .05$

The only statistically significant difference in quality rating is for degree of unity in the writing of the high-achieving students. Nevertheless, the direction of the difference in nearly every instance, for both high- and low-achieving students, is the same as that for the one statistically significant result: the writing is better by pen.

T-Unit Analyses

An exploratory investigation was performed on the matched papers selected for the rhetorical analyses in order to determine whether T-unit length was affected by computer use. There was no difference between the two conditions.

Videotape Recordings

Certain students were videotaped in the act of composing their pieces on the computer. That is, the screen itself was recorded in order to capture aspects of the process that were transient. Students were observed thus both in the process of composing first drafts on screen as well as revising first drafts.

For those students whom we recorded composing first drafts on screen, comparisons were made with texts that they had composed by pen in order to determine whether there were differences in the number or kind of revisions made during the process of a first draft depending upon the condition of writing. In fact, there were none. Students were as likely to make changes during the process of their first draft on screen as they were on paper.

Composing Patterns. A different kind of analysis was performed on the videotape recordings of the composing episodes. The various behaviours evinced were categorized into three different kinds of activities: composing and revising; correcting typographical errors; loading, formatting, and saving. In other words, an attempt was made to separate out those activities that were computer-specific in order to determine how much time was being absorbed by the technology. Table 7.17 presents the findings for the thirteen Grade 8 students who were involved in composing or revising as they were being videotaped.

TABLE 7.17: PERCENTAGE OF TIME GRADE 8 STUDENTS DEVOTED TO SPECIFIC COMPOSING ACTIVITIES

	Composing/ Revising	Correcting Typing Errors	Loading/ Formatting/ Saving
Student 1	80.3	2.8	16.9
Student 2	57.4	1.2	41.4
Student 3	75.8	1.7	22.5
Student 4	51.6	8.3	40.1
Student 5	84.7	5.1	10.2
Student 6	47.0	1.2	51.8
Student 7	71.8	5.5	22.7
Student 8	76.4	3.5	20.1
Student 9	79.7	6.6	13.7
Student 10	80.1	4.9	15.0
Student 11	83.8	3.3	12.9
Student 12	74.7	3.0	22.3
Student 13	81.3	12.0	6.7
Mean	73.6	4.6	21.7

Two things are apparent in this table. First of all, on average approximately 25% of the time supposedly devoted to composing and revising was in fact given over to computer-specific activities. (This does not include the time spent printing, or waiting at the printer, asking advice about formatting or commands, etc. These activities are captured in the analysis below of classroom behaviours.) Secondly, there is considerable variation by student: one student spent 12% of the time correcting typing errors, while others spend just over 1%; two students spent over 40% of their time loading and formatting, while one spent only 6%. The point is that some students are able to contain the amount of time devoted to the technology far more efficiently.

At the Grade 12 level, only three students in the principal study were videotaped. None of the classes at this level used Commodores, the computer which lent itself to videotaping, and the three students who were observed did their composing using the Carleton Commodore lab on weekends. Table 7.18 summarizes the findings for these three students.

TABLE 7.18: PERCENTAGE OF TIME GRADE 12A STUDENTS DEVOTED TO SPECIFIC COMPOSING ACTIVITIES

	Composing/ Revising	Correcting Typing Errors	Loading/ Formatting/ Saving
Student 1	85.5	4.3	10.2
Student 2	88.8	1.6	9.6
Student 3	83.9	1.1	15.0
Mean	86.3	2.1	11.6

It is interesting to note that, on average, these Grade 12 students devoted less time to the technology than the Grade 8 students. This may suggest an effect of maturation, or degree of experience with the computer; however, the numbers are far too small to be significant. What is interesting is that, with the Grade 12 students too, there is considerable variation in time allotted to computer-specific activities.

One final point. On the whole, the time devoted to loading and formatting came in chunks, especially at the beginning of composing episodes. The correction of typographical errors, however, typically recurred throughout the composing or revising, as persistent short interruptions.

Classroom Behaviours

At certain points in the classroom observations, whole-class behaviours were coded using the instrument described in Chapter Six. As described in that chapter, for the period of an entire writing session, generally one class period, the researcher recorded students' behaviours in a fixed order during five-second intervals according to one of the categories specified in the code-sheet. A total of twenty-eight sessions were recorded for the two classes.

Categories on the code-sheet (and replicated in Table 7.19) are, on the whole, self-explanatory. Some, however, need clarification. Since the researcher observed at something of a distance, the distinction between composing and revising was determined as follows. If a student was adding to the end of a text, that was categorized as composing; if the writer seemed to be inserting or manipulating

material within a text, that was coded as revising.

TABLE 7.19: COMPARISON OF MEAN PERCENTAGES OF ACTIVITIES IN COMPUTER AND PEN COMPOSITION CLASSES

	Computers (n=20 lessons)		Pen (n=8 lessons)		
Variable	M	S.D.	M	S.D.	t
Talks to friend	4.65	3.24	8.66	6.57	2.08*
Plays (doodles/fixes files)	4.60	5.33	2.43	2.34	1.07
Conferences with teacher	3.19	2.95	6.65	5.20	2.14*
Pauses (sits/thinks/ stares)	3.28	2.93	14.68	4.55	7.57***
Composes	25.32	14.97	20.74	9.54	.77
Recopies/types previous draft	7.82	10.25	6.29	3.87	.40
Formats (set-up)	7.80	5.19	0.00	0.00	-
Rereads a) draft or printout	1.83	2.42	7.16	3.41	4.50***
b) computer screen	5.11	4.17	0.00	0.00	-
Revises	10.21	6.75	1.34	1.86	3.53**
Conferences with peers					
a) reads draft	1.55	3.08	4.40	3.39	2.07*
b) listens	.63	1.21	7.48	27.72	5.28***
c) discusses	5.54	3.27	14.44	25.72	5.30***
Asks/tells how to spell	1.48	1.97	.66	1.36	1.34
Asks/tells computer commands	1.65	2.38	0.00	0.00	-
Reference use	2.02	3.26	2.63	1.81	.48
At printer	10.57	8.28	0.00	0.00	-
Other activity	2.79	4.47	2.46	1.57	.20
Total	100.00		100.00		

Note: Mean scores represent percentages of total scores coded in all categories.

*p < .05 **p < .01 ***p < .001.

Consequently, students who were rewriting a whole new draft, or new sections of a draft, would have been categorized as composing, although closer inspection might have defined the activity as revising. This may have affected the relative apportionment of revising and composing activities, as the discussion below will suggest.

For the complete analysis, data was tallied by category for each writing session, then the category total was converted to a percentage of the total tallies for all categories for that session. This conversion from raw scores to percentages made comparisons more accurate by removing error factors that would have resulted from faster codings during some classes and differing lengths of writing sessions.

Finally, the data from two specific classes were compared: in one, all the students were composing on the computer, in the other, all were writing by pen. (Since many sessions were observed for each class, the data reported here represent means.) Writing pedagogy in both classes was comparable in that both teachers had worked towards engaging their students in a complete writing process. (Revision analyses also showed the two classes to be comparable when writing by pen.)

Two-tailed *t*-tests were performed to discover any significant differences in the category percentages, and significant differences were found in a number of activities. See Table 7.19. Students writing by pen spent more time talking to friends. This activity is distinguished from the kind of talk that takes place over a draft: such talk may include generating ideas; it may also include

undirected social talk. Whether the talk was task-related or not could not be determined by long-distance observation.

Students writing by pen also spent much more time pausing: that is, sitting and staring before and during the composing. Similarly, the pen-writers spent more time conferencing; significant differences were found for each of the categories and subcategories: conferences with teachers; conferences with peers; reads draft, listens, and discusses.

In contrast, the computer students spent more time formatting (7.8% of their time), discussing computer commands (1.65%), and working or waiting at the printer (10.57%). These computer-specific activities account for 20% of the classroom time. (Note that the videotape analyses revealed that some of the time classified in Table 7.19 as composing or revising was also taken up by the technology.)

Somewhat surprisingly, computer students spent significantly more time revising in general. This finding seems inconsistent with earlier findings of the revision analyses, which indicated that computer students made fewer revisions than those writing by pen. These conflicting results can be explained in one of two ways. First, it may be that not all the revision activities of the students writing by pen were captured. As suggested above, some of the activities defined as composing (and pausing) may have indeed involved revising. Note that those writing by pen did spend more time on average composing than did the computer students, although the difference was not statistically significant.

A more plausible explanation, in the light of findings from the videotape analysis, is the following. The computer students may have

spent more time revising because revising by computer takes more time. That is, except for reordering of large discourse units (which is a relatively rare revision operation for these students), it is much faster to revise by pen. Deletion, for example, simply involves a single extended pen stroke. Further, at least some of the revision entailed correction of typographical errors -- a computer-specific activity. In other words, some of the time spent revising on the computer involved computer-related activities.

To sum up, the computer diverted a significant amount of time from the task of composing. The time-saving factor normally ascribed to the computer is clearly questionable. Furthermore, the time devoted to the computer seemed to come at the expense of those activities involving interactions with others -- students or teachers -- over texts-in-progress. That is to say, the time spent by the computer students in dealing with the technology was spent by the pen students interacting with others over work in progress.

Gender

One question asked of the data related to the influence of gender. Specifically, we wished to know whether girls were more or less likely to make revisions when writing by computer as compared with boys. For this reason, two-way analyses of variance (by gender and condition: pen vs. computer) were performed on scripts produced in those classes where students wrote both by pen and computer. Table 7.20 summarizes the results.

TABLE 7.20: TWO-WAY ANALYSES OF VARIANCE ON REVISIONS BY GENDER AND CONDITION IN CLASSES IN WHICH STUDENTS WROTE IN BOTH CONDITIONS

	df	MS	F	p
Sums per 50 words:				
Additions				
Gender	1,251	.000	.000	.999
Condition	1,251	17.731	33.193	.000
Interaction	1,251	.153	.286	.593
Deletions				
Gender	1,251	2.518	6.439	.012
Condition	1,251	13.823	35.348	.000
Interaction	1,251	1.308	3.345	.069
Reorderings				
Gender	1,251	.008	.236	.628
Condition	1,251	.521	14.800	.000
Interaction	1,251	.000	.000	.998
Substitutions				
Gender	1,251	.031	.043	.835
Condition	1,251	30.146	41.702	.000
Interaction	1,251	.349	.483	.488
Total changes per 50 words:				
Word:				
Gender	1,251	2.794	.705	.402
Condition	1,251	199.964	50.499	.000
Interaction	1,251	4.515	1.140	.287
Changes by level per 50 words:				
Gender	1,251	.047	.054	.816
Condition	1,251	39.189	45.037	.000
Interaction	1,251	.202	.232	.631
Phrase:				
Gender	1,251	1.614	1.836	.177
Condition	1,251	34.886	39.687	.000
Interaction	1,251	1.399	1.592	.208
Sentence:				
Gender	1,251	.135	.484	.487
Condition	1,251	4.241	15.233	.000
Interaction	1,251	.185	.664	.416
Idea:				
Gender	1,251	.009	.424	.515
Condition	1,251	.041	.688	.408
Interaction	1,251	.001	.058	.809
Section:				
Gender	1,251	.008	3.666	.057
Condition	1,251	.041	18.232	.000
Interaction	1,251	.009	4.191	.042

For each kind and level of revision, the influence of condition is significant: as we have seen elsewhere, the students revise considerably more by pen. Gender, in contrast, seems to have almost no influence. Only the F-statistic with respect to deletion is significant, and given the findings for all other revisions operations and levels, that result must be considered random. Most significantly, there is no interaction effect. Girls are no more likely to make revisions with the computer than boys, and vice versa.

Preference Patterns. The influence of gender was examined from another perspective as well. In some of the classes, students were either explicitly or implicitly given a choice as to whether to compose by computer or by pen. That is, in some classes, volunteers were enlisted at the outset for the computer condition. In others, all students were initially expected to take a turn at the computer, but nothing was said if, over the year, they drifted back to their pens.

These self-selection patterns were analysed as to gender preference. Because the proportion of males and females varied by class, the percentage of students self-selecting to use the computer was calculated by grade level.

Table 7.21 summarizes the findings for those classes when students were given the option.

Note that the most remarkable finding is that at each grade level a far greater percentage of students chose to abstain. As to gender, there were no real differences between males and females except at the 12G level where twice the percentage of girls volunteered. The absolute numbers are not great enough to be able to

generalize with confidence for the 12G's. What is clear from the data, though is that girls are not less likely to self-select to use the computer.

TABLE 7.21: VOLUNTEER PATTERNS BY GENDER

	Volunteers		Abstainers	
	(n)	(%)	(n)	(%)
12A Females	(15)	25.4	(44)	74.6
12A Males	(11)	23.9	(35)	76.1
12G Females	(6)	37.5	(10)	62.5
12G Males	(4)	18.2	(18)	81.8
12 Females	(21)	28.0	(54)	72.0
12 Males	(15)	22.0	(53)	78.0

CHAPTER EIGHT: SUPPLEMENTARY STUDIES

As the discussions in Chapters Four and Five suggest, in many classes the computer did not have a fair trial, because of limitations in both computer accessibility as well as composition pedagogy. It was only in one Grade 8 class in fact, that both factors were favourable: that is, the pedagogy was based on a process approach, and the computers were as accessible as is likely to be the case within the school system.

For this reason, we decided to perform two supplementary studies designed to explore the consequences of computer use in the writing of students at the Grade 12 level in settings that were more favourable. Specifically, we sought to find or set up situations where a process approach to writing was prevalent and where computers were accessible, in all senses. In the end, we set up our own 36-hour writing program at Carleton University for high school students to form the basis of one study. For the second, we were able to pinpoint a specific Grade 12 class that was to be taught in the year following our study. That class seemed ideal because a new ICON computer lab recently established at the school had been promised to the writing teacher on a regular basis and because the teacher intended to repeat the same very successful pedagogy (the mix of de Bono thinking strategies with a process approach) for the coming year.

Supplementary Study A: The Carleton Study

The first supplementary study took place at Carleton University. In order to control the pedagogic and computer-related circumstances as closely as possible, we decided to stage one study directly under our own supervision. With this in mind, an announcement was made in the writing class of one local high school: students were offered payment in return for their participation in a study that involved writing with the computer. The students were all completing a Grade 11 writing class, whose instructor was committed to a process pedagogy.

Seven students volunteered to participate: five females and two males. Individual interviews with the students revealed that all had had considerable experience writing essays during the previous two years, writing between 20 and 60 essays each, from one to ten pages in length. (See Appendix D.1 for the interview format.) Four of the seven students wrote poetry and short stories for pleasure and all did a considerable amount of reading. Three of the seven had computers at home, but none had used computers for word processing.

For twelve days, these students attended Carleton University for three hours a day in order to compose. (One of the students was unable to participate on the last two days.) At Carleton, a computer lab facility was made available for this purpose. The room held fifteen to eighteen Commodores and one printer. The word-processing program selected was PaperClip -- selected for its flexibility and learnability. Three researchers were on site all the time: one to provide specific instruction in and help with

computing; a second to function as the writing process teacher; and a third to observe. The observations of all three formed the basis of the final analysis.

On the first morning, students were given some basic instruction in using the PaperClip program. A member of the research team provided the instruction, beginning first with large text moves, proceeding to sentence, phrase, and then word level changes. (This procedure was suggested with the intention of discouraging students from concentrating on micro level changes.) Students then practised the word-processing commands on their own computer using the same paragraph of argumentative text on which they had received instruction. In addition, students were given a list of the commands for ready reference. The instruction and practice took approximately one hour.

Students were then given handouts containing the first paragraph of the pre-test instructions used in the main study. That is, they were encouraged to think of a topic for an opinion piece, using whatever methods they were comfortable with for generating topics. They were encouraged to confer with each other and to move about as they wished.

Once the first piece was brought to a completion satisfactory to them, the students were asked to compose any piece of their choice: most selected a narrative. The third piece was to be another argument, and some students had time for a fourth essay of their own choosing.

The length of time to be devoted to each composing session was left open initially. We did not know how much time students were

able and prepared to devote to composing on the computer. Within the first two days, a rhythm was established by the students themselves, in which they composed for three hours straight, with a short break half way through (a break almost inevitably initiated by the researchers.)

Ten three-hour sessions were devoted to composing on the computer. At the end of these sessions, six of the seven students spent two more days composing a new argumentative piece by hand. (The student who dropped out did so because of reasons external to the study.) Once again, one researcher functioned as a process teacher, orchestrating interactions where possible and intervening when appropriate. A second researcher observed.

At the end of the ten sessions, all seven students were asked to fill in a questionnaire about composing on the computer. (See Appendix D.2.) Subsequently, an hour was devoted to a communal discussion about the power and limitations of composing on a computer. This discussion was taped and analysed in the context of the questionnaire responses as well as the observations.

During the ten days in which students composed at the computer, each day a different student's screen was videotaped. After all the scripts were completed, they were analysed for number and kind of revisions between first and last drafts using the same instrument as in the main study. Subsequently, the final copies of all essays, handwritten and computer-produced, were retyped by a secretary, and these typed scripts were analysed according to the rhetorical criteria. The results of all these analyses are presented in Chapter Nine.

Supplementary Study B: Enriched Students Composing with an ICON

Our second supplementary study took place in a regular high school class. The students observed were an enriched 12A English class: that is, the students were students of exceptional ability, and the English curriculum included literary study as well as writing. In addition, because it was an enriched class, the total number of students was thirteen -- eleven females and two males.

For their writing sessions in the fall, an ICON computer lab was made available to all students. The lab held sixteen computers and one printer. In addition, a new word-processing software package was made available for use on the ICON. What students had been using in the preceding year was a text-editing package (although neither the writing teachers nor the computer teachers in the two relevant schools were aware of the distinction.) This package had been cumbersome and simply inappropriate. The development of WPro, a wordprocessing package based on Word Star and simplified for the ICON, provided a great boon for the students. The program is menu-driven, and students learned the relevant commands easily. (The only major problem cropped up late in the program, when some students learned to enter the teacher's files and made a variety of unappreciated changes.)

As to the writing pedagogy, the teacher embarked on a program identical to that undertaken the preceding spring with her Grade 12 advanced class. That is, she taught the students certain de Bono thinking strategies and showed how these could be incorporated as generating strategies in the composing process.

(Appendix D.3 consists of two handouts based on de Bono strategies: Consider All Factors, and Plus, Minus, Interesting.) At the same time, the composing of argumentative pieces was performed in the broader context of preparing for a public debate. Teams of students consequently felt immediate responsibility for the forcefulness of each other's arguments and for that reason, were far more likely to encourage meaningful revisions.

Students were encouraged to produce printouts at the end of each session, and these, along with all written prefigurings, were collected for analysis. These pieces were subjected to rhetorical as well as revision analyses, and were compared to the handwritten scripts produced the preceding spring by Grade 12 advanced students taught by the same teacher in the same way. We realized that comparisons would be problematic, since the computer group consisted of enriched students, while the pen group in this case was advanced. As it turned out, however, the enriched group was the only Grade 12A class which met our specifications -- with respect to pedagogy and computer accessibility. In addition, as suggested above, there seemed to be some advantage to be gained in giving the computer the most favourable trial possible.

CHAPTER NINE: FINDINGS OF SUPPLEMENTARY STUDIES

The results of the two supplementary studies will be discussed together. Identical text analyses of the computer scripts produced during the treatments were performed for the two studies with one difference: in Supplementary Study A (the Carleton group), comparisons were made between the computer scripts and the pen scripts produced by the same students; in Supplementary Study B (the enriched 12A English class), the experimental group produced only computer scripts and so comparisons were made with a set of handwritten scripts produced by a class of Grade 12 advanced students taught by the same teacher using the same pedagogic approach the previous year. In other words, pedagogy was matched for the control group, but not ability level.

Because the research in Supplementary Study A was orchestrated by the researchers, far more extensive observation of varying kinds was possible with this group of students. Computers were selected that allowed for videotaping, and at all times, at least three researchers were in the room both to observe as well as to ensure that all mechanical problems were eliminated. For this reason, most of the discussion to follow, which derives from close observation, is based on the Carleton study and will be so indicated.

Revision Analyses

The scripts produced by the students involved in both supplementary studies were all subjected to revision analysis. The number and kind of revisions between the first and last drafts were determined and the totals were converted to revisions per 50 words of text. Tables 9.1, 9.2 and 9.3 summarize the findings.

TABLE 9.1: MEAN NUMBER OF REVISIONS PER 50 WORDS FOR SCRIPTS IN SUPPLEMENTARY STUDY A

	Arguments				Narratives	
	Pen (n=6)		Computer (n=13)		Computer (n=7)	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Total Additions	.436	(.384)	.241	(.227)	.240	(.238)
Total Deletions	.294	(.290)	.198	(.253)	.142	(.136)
Total Reorderings	.073	(.120)	.038	(.069)	.039	(.080)
Total Substitutions	.832	(.812)	.434	(.364)	.530	(.549)
Total Changes	1.635	(1.462)	.911	(.737)	.951	(.929)
Changes at Word Level	.676	(.722)	.292	(.317)	.404	(.442)
Changes at Phrase Level	.489	(.573)	.311	(.316)	.369	(.449)
Changes at Sentence Level	.256	(.311)	.189	(.206)	.114	(.142)
Changes at Idea Level	.124	(.255)	.070	(.147)	.000	(.000)
Changes at Section Level	.090	(.173)	.049	(.067)	.063	(.075)

TABLE 9.2: COMPARISON OF MEAN NUMBER OF REVISIONS PER 50 WORDS IN ARGUMENTS WRITTEN BY PEN VS. ARGUMENTS WRITTEN BY COMPUTER IN SUPPLEMENTARY STUDY A

	Pen (n=6)	Computer (n=13)	F	p
Deletions at Word Level	.10	.10	3.87	.0413
Reordering at Section Level	.00	.01	8.85	.0023
Substitutions of Word for Word	.23	.12	3.82	.0427
Phrase for Word	.14	.05	3.76	.0445
Sentence for Sentence	.17	.05	7.23	.0053
Total Substitutions	.83	.43	3.35	.0593
Total Changes	1.63	.91	3.80	.0432
Changes at Word Level	.68	.29	4.97	.0199

Specifically, Table 9.1 summarizes the results for Supplementary Study A, comparing the computer scripts to those written by hand and classifying the scripts by mode: narrative/descriptive vs. argumentative. Consistent with our findings in the principal study, these students made far more revisions when they wrote arguments than when they wrote narratives. For this reason, analyses of variance were performed only on the argumentative pieces in order to determine the effect of computer use. Table 9.2 summarizes the findings where the differences were statistically significant. Except for the category "reordering of section," (where the comparison was between .0084 and .0000 instances per 50 words) there were significantly more revisions in the handwritten essays than in the computer-produced arguments for

all the categories.

TABLE 9.3: COMPARISON OF MEAN NUMBER OF REVISIONS PER 50 WORDS IN ARGUMENTS WRITTEN BY ENRICHED STUDENTS ON COMPUTER VS. ADVANCED STUDENTS BY PEN IN SUPPLEMENTARY STUDY B

	Pen (n=26)		Computer (n=9)			
	M	S.D.	M	S.D.	F	p
Sums Per 50 Words:						
Additions	.81	.57	.51	.59	1.73	.1978
Deletions	.73	.51	.25	.53	5.95	.0202
Reorderings	.13	.18	.08	.16	.65	.4252
Substitutions	1.39	.83	.58	.58	7.28	.0109
Total Changes Per 50 Words:	3.06	1.78	1.42	1.73	5.79	.0219
Changes by Levels Per 50 Words:						
Word	1.49	1.00	.49	.59	8.08	.0076
Phrase	1.26	.81	.54	.69	5.63	.0236
Sentence	.23	.23	.32	.47	.59	.4478
Idea	.08	.15	.04	.08	.69	.4117
Section	.00	.01	.04	.06	7.02	.0123

Table 9.3 summarizes the findings for Supplementary Study B. That is, the arguments produced on computer by the enriched students in the experimental group were compared to those written by pen by a

pedagogically matched group of advanced students. Analyses of variance revealed that there were significantly more revisions in the handwritten essays for the following categories: total number of changes per 50 words, total number of deletions per 50 words, total number of substitutions per 50 words, total number of changes at word level per 50 words, and total number of changes at phrase level. It was only in changes at the section level, where the instances were very small in both conditions, that the results favoured the computer condition. The results of the revision analyses from both supplementary studies, then, are consistent with the findings from the main study: students revise more by pen.

Videotape Analysis

In Supplementary Study A, students composed on Commodore computers, and while they did so, a VCR was hooked up to record the screen -- and consequently the kinds of changes that took place during the composing or revising. On the basis of these video transcripts, comparisons were made between the pen and computer conditions. Specifically, the number and kind of revisions produced during the first draft of the computer scripts were compared to the number and kind of revisions produced in the handwritten first drafts of the same students. No differences were found. In other words, students were as likely to make revisions in composing the first draft in both conditions. It was in revising that first draft that the differences were in favour of the pen.

Changes in Revising Patterns Over Time

In order to determine whether students were likely to make more revisions once they become more familiar with the possibilities of the word processor, comparisons were made between the number of revisions to the first computer-produced argument and the last, for each student in the Carleton study. There were no differences between the two sets: the mean number of revisions was the same, and three of the seven students made more revisions in the first essay.

Word Length

Comparisons were also made with respect to word length. Table 9.4 compares the length of the scripts produced in the Carleton Study when classified by student, as well as by mode (narrative vs. argument) and condition (pen vs. computer). The table clearly indicates the following. First, the five students who wrote narratives almost always wrote longer pieces in that mode. Second, with one exception, students wrote far more on the computer than by pen. In other words, these students were more fluent writing narratives than arguments, and more fluent on the computer than by pen. These results are consistent with the findings for the 12A students in the principal study.

TABLE 9.4: LENGTH OF FINAL DRAFTS IN SUPPLEMENTARY STUDY A

	Computer			Pen
	Narrative	Argumentative 1st	2nd	Argumentative
Sandra	702	571	503	450
Glen	1465 1196 807	795	847	533
Sam	2046	1249	708	-
Ashley	-	527	563	314
Susan	-	341	374	292
Judy	506	456	385	473
Linda	473	359	436	231

Rhetorical Analysis

The scripts in both supplementary studies were also analysed using the rhetorical scale described in Chapter Five. For Supplementary Study A, the final copies of the three arguments written by each of the six students who wrote both by pen and computer were rated according to the rhetorical criteria. There were twelve essays produced by computer and six by pen. A difference-of-the-means *t*-test revealed that there were no statistically significant differences between the two conditions. See Table 9.5.

TABLE 9.5: RHETORICAL ANALYSIS OF SUPPLEMENTARY STUDY A: PEN VS. COMPUTER

	Pen (n=6)		Computer (n=12)		
	M	S.D.	M	S.D.	t
Criteria:					
Unity	5.7	1.84	5.8	1.33	.14
Organization	5.6	1.75	5.7	1.43	.14
Development	5.2	1.46	5.5	1.08	.85
Register	6.1	.95	6.4	.91	.99
Overall Stylistic Effectiveness	5.5	1.61	5.8	.85	.79
Sentence Structure	4.8	1.07	5.3	1.13	1.03
Range of Vocabulary	6.3	.92	6.2	.90	.26
Vividness	4.8	1.46	4.6	.81	.64
Economy	5.2	1.34	5.3	.94	.41
Reader Awareness	5.2	1.86	5.9	.78	1.56

For Supplementary Study B, the scripts produced by the experimental enriched students were compared to the handwritten arguments of the control advanced students. Note that in the end, as a result of attrition, absences, etc., pieces by only nine of the thirteen enriched students were available and/or considered appropriate for analysis. These were compared to eighteen scripts produced in the preceding year by advanced students. Table 9.6 summarizes the results.

TABLE 9.6: RHETORICAL ANALYSIS OF SUPPLEMENTARY STUDY B

	Pen (Advanced) (n=18)		Computer (Enriched) (n=9)		
	M	S.D.	M	S.D.	t
Criteria:					
Unity	3.9	1.03	3.9	1.59	.10
Organization	3.6	.92	4.0	1.41	1.10
Development	3.6	.89	4.1	1.31	1.53
Register	4.3	1.33	5.1	1.54	1.67
Overall Stylistic Effectiveness	3.8	.96	4.2	1.34	1.03
Sentence Structure	3.5	1.04	4.3	1.19	2.33*
Range of Vocabulary	4.1	1.15	4.8	1.07	2.35*
Vividness	3.2	.94	4.0	1.05	2.80**
Economy	3.6	.92	4.1	.87	1.78
Reader Awareness	4.2	1.11	4.8	1.44	1.54

* p. < .05
** p. < .01

Note that, as opposed to the findings of the principal study and the Carleton study, the rhetorical analysis in this case points to the superiority of the computer condition. There are statistically significant differences in favour of the computer on three variables: sentence structure, range of vocabulary, and vividness. And the tendency on several other variables is in the same direction.

The difficulty, of course, is that the students being compared were not of the same ability level. The computer students were all enriched, while those who wrote by pen were advanced. In other words, the differences in rhetorical quality cannot be attributed to the use of the computer alone -- or perhaps at all. One would have expected the enriched students to perform at a significantly higher level, especially with respect to criteria like sentence structure and range of vocabulary. Furthermore, since we have no evidence of the enriched students' performance by pen, we cannot even be sure that the computer did not disadvantage them; all that we know with certainty is that, using the computer, they were able to produce scripts that, on several criteria, were significantly superior to those handwritten by advanced students.

Student Self-Analyses

In addition to analysing the scripts produced by computer, we were able to get considerable insight into composing processes and patterns through a variety of other sources. One such source, in the Carleton study, was the students' own self-analyses. Students' reactions about their experience writing with the computer were tapped at three points. First, researchers chatted informally with the students during and immediately after the set of sessions. Secondly, each student filled in a questionnaire individually. (See Appendix D.2.) Third, at the end of the computer writing session, a formal discussion was orchestrated: this session was taped and later analysed.

Students' Reactions

Oral Responses. Initial informal oral reactions by students on use of the computers for writing were mixed. Several said it was fun and seemed faster than writing with pen, but others disagreed. Several said that the computer blocked their thinking processes and they preferred to write with pen first and then enter the text. One of these was a student who types 60 wpm and another was the poorest typist who used one finger of one hand. Students did feel that they made more revisions on the screen than when writing with pen. (Note that these impressions were not borne out by analysis of the tapes.) Most changes, they said, were at the word, phrase, and sentence levels. Only three of the seven had used the text move command after writing the first argumentative essay. All found that the printouts were of little use until they had finished the first draft; although they said they could see where revisions were needed when reading the printout, they were less likely to see the need for revisions on the screen.

Questionnaire and Group Discussion. Students' responses during the final taped group discussion and to the questionnaire following the two weeks revealed again the considerable diversity among students' answers. Four felt they wrote as well using the computer as they did by pen, but three felt the computer made the writing a little worse. None, however, felt the computer was a great advantage to their writing. Three classified the computer as a useful tool, two said it was just a fancy typewriter, and two saw it as a disadvantage to their writing.

Advantages of Computer Use. Table 9.7 lists all the students' responses to the question concerning the advantage of using a computer. Common themes in these responses as well as in the discussion session were that the computer makes editing easier, that the text looks neater, and that no rewriting is necessary.

TABLE 9.7: STUDENT RESPONSES TO QUESTION 3

Question: In what ways does the computer make writing easier?

1. When the ideas are in your head, it is very easy to type on the screen. The final copy is neat and typed.
2. I am able to edit the essay and it is always neat, no rewriting.
3. It's a lot faster, correcting errors are easier.
4. The computer allows you to get ideas on the screen. Ideas seem to come quickly, yet they had no order.
5. Only easier for making corrections (don't have to recopy) -- technical corrections.
6. The writing is clearer and changes are much easier to make.
7. Easier to correct, neater.

Disadvantages of Computer Use. Table 9.8 lists the responses to the question concerning the disadvantages of computer use. Several common themes emerge, themes that were amplified in the discussion. First, some students complained about their lack of typing skills. Others felt that playing with the keys was a distraction from the composing task. And some were irritated by typographical mistakes on screen that demanded attention. Most referred to the limited amount of text on screen at one time as a real barrier in their composing.

TABLE 9.8: STUDENT RESPONSES TO QUESTION 4

Question: In what ways does the computer make writing harder?

1. You don't have your full story in front of you. You are stuck in a chair, no freedom of movement.

2. It took a long time because I had to concentrate on typing and it was difficult to make revisions on the screen.

3. Stuck for words, ideas either came right away or took a lot of thinking about. When I was stuck the computer became a distraction, I started to play around with the keys.

4. The computer seems to block words. I found it difficult to be precise at times, instead I tended to ramble. I also found my work was very disorganized and unclear. Translating thoughts on the computer was very difficult.

5. Much harder to come by ideas. The neatness of it was a real mental block -- ideas etc. just didn't come very well.

6. The entire screen cannot be seen, and mistakes are harder to leave behind; it is so easy to correct them right away.

7. Less creative -- words don't come as easily. Typing is slow for me.

One seeming advantage of the computer was sometimes a hindrance: the fact that text looked neat often seduced the writer into being prematurely satisfied. One student also found the neatness an obstacle in a different way: "The neatness of it was a real mental block -- ideas, etc. just didn't come very well."

Several students also felt that generating was more difficult on the computer; they had difficulty beginning. Others found that words came quickly but that what was produced on screen tended to be less organized. In other words, many students felt the computer produced profound changes in their composing processes.

Differences in Processes. When asked directly how their processes differed in the two conditions, the students gave a variety of responses amplifying many of the points in the preceding sections. See Table 9.9 for the precise wording of the answers to the questionnaire question.

One student clearly felt that composing at the computer was an advantage. Making copies regularly encouraged him to reread more regularly than he did in handwriting. Further, he worked over his writing much more: "I also wrote much longer paragraphs which were much more carefully worded since I could see the screen and because I had a greater temptation to edit."

Other students complained about the physical constraints of working at the computer: "You have to be sitting straight at a desk and I can't work that way." Significantly, the same students complained that their production at the computer was of inferior quality: one felt the ideas were poorer and the prose less flowing; the other felt that her writing became overly neat and organized -- "mechanical". Both students suggested a relationship between the ability to move about easily and to compose fluidly or insightfully, and it was only when writing by pen that the requisite physical freedom was possible.

TABLE 9.9: STUDENT RESPONSES TO QUESTION 5

Question: In what ways is your composing process different when you use a computer?

1. When using a computer, you are always in the "writing stage." On paper, guidelines or ruff (sic) work is done before you being your final copy. On the computer, you seem to write word by word, where on paper, you have a larger scale (ex. sentence to sentence, paragraph to paragraph.) The reason for this is because of the cursor, where you type the word you wait and then space and then think of a new word. On paper it's very free-flowing and continuous writing.

2. On a computer, I am unable to write my thoughts down (point form). My thoughts didn't flow as freely -- it was difficult to brain storm. I found I didn't make as many revisions on a computer and yet I needed to.

3. I found it harder to find a start when I was on the computer. I never usually do more than one draft on paper, but on the computer it took as many as three to get a final copy. I also spent much longer on a topic and rarely got it finished in less than a week. Computer made me revise more and delete more. I was always unsatisfied with what I had done.

4. Usually, when I write with paper, I make notes as an outline to what I want to write. With the computer, I tended to start right away. My sentences weren't very smooth flowing, and my ideas were mixed. I also found that, sitting at a desk made it hard to think, as with paper I like to move around (couch, bed). The printout gave me the impression that I was finished. I was unable to see where my mistakes were. I thought I was finished after the first draft. With a pen I'm more aware of mistakes (grammar, sentence structure) as I write. I'm much more concise when I write by pen.

5. The ideas would only come rarely -- and when they did -- bang -- that would be it. I'd have a neat little paragraph and I'd be stuck here for another 20 minutes with no ideas -- I had to go back to paper quite a bit in order to get anything. My composing in general became very neat and organized in general -- and mechanical -- and I never really got going with my projects never really "got into" them because of that. I also hated it -- the composing -- because with a computer you have to be sitting, straight at a desk, and I can't work that way.

6. Making copies once every hour made it easier to see my mistakes, since usually when I write with paper I don't reread earlier sections. I also wrote much longer paragraphs which were much more carefully worded since I could see the screen and because I had a greater temptation to edit.

7. I really don't know. I never really knew what my composing process was. I just sort of did it. I don't think it was any different on the computer. Well it was. I guess I was much more conscious of the steps: 1st write down facts, then doing 1st draft, etc. It's hard to explain.

Many referred again to difficulties beginning a piece on the computer, and to problems generating ideas. Furthermore, during the composing itself, the computer prevented one from keeping in touch with the piece as a whole in two ways. Several students complained of the limited amount of text on screen: "I found myself babbling and not remembering what I wrote before. I like having everything in front of me." "It's harder to get the whole idea of the thing, harder to make things flow well." Interestingly, one student argued that it was the cursor that kept him focused on the micro level: "On the computer, you seem to write word by word, where on paper, you have a larger scale. The reason for this . . . the cursor."

Attitudes. One question asked students whether they enjoyed writing on the computer as compared to writing by pen. The responses were significantly split. Four of the seven said no; one of these four said that she would never again use a computer for writing. A fifth student wrote, "I found no difference [in enjoyment]. I always enjoy writing no matter were it is done. It just changes the way you write." The two remaining students stated clearly that they enjoyed writing on the computer.

Changes in Composing as a Result of Computer Use

When asked how their writing changed over the two weeks, again answers were diverse. Three felt there was no change and another wrote that some change occurred for reasons unrelated to computer use. However, three felt the computer did change the way they wrote:

> I have become much more careful in writing and sentence structure and have begun to write much longer, more indepth paragraphs. I became more and more comfortable with the

computer and I feel I will miss the editing functions in future writing endeavours. I am also much more apt to revise now in a way I didn't before.

I now elaborate more. I might be more conscious of mistakes. After I finish a story I will reread it and add more ideas because I'll know I'm probably not done.

End-of-Session Reactions

Following the two days students wrote an argumentative essay by pen, their impressions were again solicited informally. Again, the responses were mixed.

I feel I accomplished as much in two days writing as in two days on the computer. I was more comfortable with the pen and paper though.

In two days I got just as much work done as I did in four days for the same type of assignment while on the computer.

I think the last two days have had a more relaxed atmosphere as compared to the last two weeks. Everyone felt more free to talk.

The neatness factor was a major one, and the variety of things you could do with the computer cannot be done with a pen and paper.

I missed being able to doodle whenever I got stuck.

I wrote much more on the computer but the quality wasn't as good.

What I really missed was the word processing. I found myself wanting to delete sentences or paragraphs of my handwriting.

My handwritting was much less organized - with the computer you begin by feeling clean and orderly and you have to continue that way, but with the handwriting - I just let it go where it wants to and piece it together later - I like knowing I have a bit of a mess to wade through.

Observations of Student Behaviours

Composing on a Computer. For the Carleton study, three researchers observed the students over the thirty-six hours and prepared reports based on their logs. Perhaps the most striking differences observed related to the degree of absorption in the two conditions. Students writing at the computer were far more absorbed by the task, or more precisely, by the screen. They wrote and wrote, often reluctant to take a break even after an hour and a half. Much of their time, when not actually typing in text, was spent in rereading what was on the screen and in pausing and staring at the screen.

This absorption was also isolating. Students only occasionally discussed their work with each other or engaged in non-writing related talk. Several read the screen of the person beside them and made brief comments, but there was little conferencing as such among students even though they were specifically seated in pairs to facilitate discussion.

Even though students seemed absorbed by their task, the writing was not easy. Beginning was a particular problem; somehow students could not accommodate their generating strategies to the technology of the computer. Some students tried to overcome this difficulty by outlining ideas on the computer. This resulted in the production of many disconnected phrases and sentences that were never transmuted into connected discourse.

A more successful strategy was to write ideas on paper first before beginning on the computer. Somehow the brainstorming on paper was more easily and effectively utilized in the composing.

(Part of the difficulty may lie in the fact that the software offered no windowing capability.) One student went so far as to complete a first draft by pen and then transfer it to the computer. Indeed, each of the students, at some point or other, resorted to using a pen -- to outline ideas, to list possible directions, or to free-write when blocked.

Writing by Pen. Students' writing processes differed in a number of ways for the two days that they wrote by pen. Most striking was the fact that they were far less absorbed by their unfolding handwritten script than they had been by the screen. They moved around much more, they chatted, and they were more eager to take breaks. Clearly, the rhythm of composing in the two conditions differed significantly.

At the same time, there was far more interaction than in the computer sessions. Students conferred far more with each other and were readier to talk to the intervening teacher. Some of this talk involved seemingly irrelevant socializing, but a great deal was also directed towards their mutual work in progress.

In other words, the composing process took a different shape for these students when they used the computer. First, they were far more engaged by the physical aspects of the process -- hypnotized almost by the screen. Their attention did not seem to wander, they were less inclined to become distracted. And the composing intervals -- the separate periods of time devoted to writing -- were considerably longer. Strategies for composing also differed. Most significantly, there was little reliance on talk -- either with peers or an adult -- at any stage of the process, either as a generating o

a revising tool.

There were two other suggestive differences. Of the nineteen pieces undertaken on the computer, only one was begun entirely afresh for the second draft. In contrast, two of the six handwritten pieces included a first exploratory draft followed by a second, which tackled the same topic from a new perspective. Despite the fact that the computer seems more plastic and malleable, for these students its use implied a greater commitment to text already produced. These words could be refined, reorganized, added to, deleted from, but never completely jettisoned to begin again.

A final potential difference was suggested by one of the participating students. It was observed that his composing by pen was far slower than his composing on the computer. When a researcher asked if this pace was typical of his writing by pen, he answered that his pen was not really as slow as it seemed since a good deal of processing was going on in his head. In view of how quickly he had composed on-screen, this is a revealing statement. Either the computer allowed him to think on screen in a way not possible to him in writing, or in writing by pen, a layer of processing was taking place that was simply absent in the computer condition. The case study described below provides another instance of this phenomenon.

Case Study

A further supplement to our research involved a case study of a strong Grade 12 writer, Derek. Derek was selected because he was known to revise extensively as a normal part of his composing process. Analysis of the drafts of a number of papers written over

the two preceding years revealed the following pattern. Typically, after discussing ideas, making exploratory notes, and brooding, he would write, usually at one sitting, a discovery draft. That draft would then be reworked extensively. First, its logic and order would be probed, leading to extensive cutting and pasting. New sections would be added, whole sections would be cut. Then, once the main line of the story or argument was clear and coherent, the writer would focus on smaller-level changes, refining the language, making it more precise, vivid, striking. At the final stage, he looked at surface errors.

As an experiment, Derek was asked to compose one out-of-class essay on the computer. He agreed. He was familiar with the computer, knew the word-processing commands (since he sometimes copied handwritten text onto the screen), and typed as quickly as he wrote. The first stage of the composing was conducted as usual. That is, he made notes by pen and discussed the ideas for his writing. The particular piece was one with which he felt he would not have to struggle. The teacher had asked for a comparison of two Shakespearean figures as tragic heroes, and he had already written a piece about a different play in these same terms the previous year. Before composing the first draft, he was able to talk through quite lucidly the essential points of his argument. He then sat down to compose the first draft on screen. He did so fluently, pausing very little, and seemingly impelled by the flow of words on the screen.

When he finished, he printed out the four-page text and reread it. In response to the researcher's question as to what he intended to do next with the text, Derek's answer was terse. "I'm going to

throw it out and start all over." He did not feel this was the kind of exploratory draft that opened new vistas; he felt the piece was "garbage," that the time spent had been entirely wasted.

Analysis of the computer-produced first draft revealed that somehow even the larger order and organization that had been in his mind when he discussed the piece initially had been lost, and there were none of the fresh insights that typically characterized his writing. This brings to mind the comment, quoted in the previous section, of the student who explained that composing by pen was slow because it allowed for a layer of processing. It is precisely this further layer of ordering that Derek recognized as absent in his computer-produced piece. Whether it was the paraphernalia of the technology that interfered -- the whole rigmarole of commands, etc. -- or the hypnotic, seductive effect of the words on screen drawing him on before sufficient ordering has taken place -- or some other dimension of the process entirely, Derek's composing on screen was clearly limited in comparison to his composing by pen. To what extent this would have altered as a result of more exposure to the computer, we do not know. Derek was not prepared to try again, whatever the financial inducement. (He was quite prepared to transfer a first draft to the screen, and to make changes on screen as well as on the printout, although he preferred the latter; it was composing a first draft on the screen that he was reluctant to do.)

We also do not know how typical Derek is. Our qualitative analyses revealed that there were no differences ON AVERAGE between the two conditions. However, the standard deviations were such as to suggest that some students wrote better and some wrote less well on

the computer. Whether this distribution was random or whether it reflected different styles is not clear from the data. In other words, it may be that some writers typically do better on the computer, and that the same number typically do worse. The very different responses of students in the Carleton Supplementary Study suggest that this may be the case; however this possibility will need to be investigated further, by focusing more closely on the composing patterns and products of students composing extensively by pen and computer.

CHAPTER TEN: DISCUSSION

At least in part because of the occasion afforded us to observe classes in action, the research described here has been suggestive in areas beyond our original question. Thus, our observations of the various writing classes involved in the study has revealed a range of practices both with respect to the use of the computer as well as to specific composing pedagogies. Some of these practices have been shown in our analyses to be considerably more conducive to achieving the teachers' stated goals, and this incidental finding has rich implications for teaching.

In addition, in responding to our primary question as to the relative value of composing with a word processor, our observations have allowed us to understand the reasons for the phenomena revealed by the script analyses, to glimpse the complex reality behind the crude numerical data. The chapter that follows will discuss these various findings, grouped according to three themes: the relative value of different writing pedagogies; the range of technical factors militating against the successful introduction of the computer in the writing class; a comparison between writing by pen and writing with a computer.

Implicit in all this is a statement with respect to research methodology. As a result of our experience in this study, and in particular of the way in which our presence in the classrooms enriched our understanding of the results of the text analyses, the

study has left us with incidental considerable confirmation of our original tacit hypothesis as to the inestimable value of observation in educational research.

Writing Pedagogies

Chapter Four has described in detail the range of composition pedagogies displayed in the classes observed. Within that range, a cluster of teachers was differentiated as embodying, with individual variation, a process approach to the teaching of writing. Four others were classified instead as demonstrating alternate pedagogies of varying kinds.

The findings of the principal study revealed important differences in the writing that emerged as a result of these different pedagogies. Specifically, students of teachers committed to a process approach revised considerably more than their peers in classes where the pedagogy was distinctly different. They made more revisions of all kinds -- additions, deletions, substitutions, and reordering -- and more revisions at all levels -- from word to discourse blocks.

At the same time, evidence from the forced-choice evaluation revealed that, in 60-70% of the cases in which extensive revisions were made, the final piece was improved -- for both computer and pen-and-paper pieces. In other words, the fact that there were more revisions in the process classes also suggests that the students in these classes were more likely to be improving their pieces and producing better final drafts.

Finally, comparisons between the revisions performed on test essays and class essays showed that, for the proponents of alternate pedagogies, there were more changes made to the test essays than class essays. And for three of the four, the test essays were all pre-tests, written before the year's instruction in compostion was begun. The directions attached to the test prompts, directions that simply insisted that a separate session be assigned to revising, were more successful in eliciting revision than the whole panoply of instructional strategies available to these classroom teachers.

In this context, it is important to remember that all the teachers -- whatever their pedagogy -- were committed to the teaching of writing, and that all normally expected more than one draft. That is, even in the classes where teachers displayed alternate pedagogies, students were advised of the value of revising. The difference was not so much in the teachers' objectives, but rather in their approach to achieving these objectives.

In the alternate classes, revision was frequently exhorted and often described and specified. In the process classes, revision was instead elicited. Specifically, revision was elicited by appropriate prompting questions, posed either by a peer (initially at least according to a set formula provided by the teacher) or by the teacher. More significantly, the revision was elicited <u>in process</u>, that is, during the creating and recreation of specific scripts. It was not so much that students were advised that revising was good (they were so advised in both kinds of classes), nor that specific criteria for revising were suggested (this was true for alternate classes as well), but that specific questions were posed of their own

work in progress, which implied the relevant criteria and suggested the appropriate revising strategies.

The strength of process classes thus derives from a number of factors. First, because the writing is done in class, in a workshop atmosphere, teachers are given the opportunity to intervene during the process when the teacher is most likely to see the student's difficulty and when the student is most likely to hear a proposed solution. Secondly, what is implicit in such an approach is the extensive opportunity for modelling. Typically, teachers themselves write one or two pieces along with the class, dramatizing their own processes and strategies, and eliciting critical evaluation on the part of the students. Furthermore, in a process classroom, the processes and strategies of their peers are laid out to student writers, so that a repertoire of potential strategies is made available to them.

Finally, the process class encourages peer interactions over work in progress, and these have many benefits. First, the writer hears the immediate response of a reader to her text: she sees what appeals, what fails, what confuses, what enlightens. Second, she receives suggestions for revision by a fellow-craftsman, suggestions she is not bound to except, but ones that may serve as potential guides. Third, the peer who must function as a critic learns how to function as a critic -- initially to a friend's unfolding script, and consequently, in the end, to his own.

The Computer in the Writing Class

The main focus of the study was to investigate the effect of computer use on the writing processes and products of elementary and high school children. Our initial expectation had been that the computer variable would be relatively constant; that, given minor variations, computers would be used in much the same way in all the classes under study. Observation of the classes where the computer was being used, however, revealed that there was no such uniformity. Classes differed in the number of computers available, their accessibility, the kind of hardware and software in use, the kind of instruction available. (Chapter Five describes the specific circumstances of computer use for each class participating in this study.)

The end result of such variation was that certain environments were far more hospitable to the use of the computer in the writing class than others. In fact, in only three classes were the circumstances with respect to computer use close to ideal: one Grade 8 class that was part of the original study, and the two classes selected for our supplementary studies.

From the point of view of our narrow research question, the circumstances surrounding computer use in the schools were frustrating (and necessitated the supplementary studies); from the perspective of curriculum planners, however, there is much to be learned from those very educational realities that constrained our research. Consequently, the next section will summarize the kinds of technical factors that we observed as militating against the successful introduction of the computer into a writing class.

Limiting Factors

Restricted Accessibility. First and foremost among these problems was that access to computers was restricted in a number of ways. In most schools, computers were segregated in a locked room of their own: in one school, the computers were in the basement and in another, in a glassed-in section of the machine-repair shop. One teacher allowed only four or five students per class period to use the computer room even though 16 machines were available. These students had to relinquish their turns to other students after one or two class periods. In another class, only four or five students used computers because that was the number of machines available. In one class there was only one computer for 24 students until the beginning of December when three more became available.

Compounding these restrictions was the fact that on several days, none of the students used any of the computers. Reasons were that there was no one to supervise (when the computers were in a distant room), or that the word-processing disk or the key for the computer room door could not be found. For most classes, at least one or more of the machines were "down" on any one day because they lacked a component part or were not hooked up properly, or because the disk drive would not load the program. In most schools, even when computers were placed in the regular classroom, students were often prohibited from using them outside class time because of a lack of supervision.

Learning to Use the Computer. In order to use the computer as a writing tool, the students need to learn word-processing commands.

Many students received very limited instruction and consequently difficulties were frequent. For the ICON, more than one teacher merely directed students to the six training programs on ICON computers. These programs were designed for the programming course, not to teach word processing. Consequently, many students did not discover how to set margins and prevent wraparound of the text until the last few classes. In many classes, there was no easy way for students to refer to commands while composing.

One source of frustration was that even the computer teacher often could not answer questions on word-processing commands because he or she was unfamiliar with the program and the options. Some students gave up attempting to learn the commands and used the machines like typewriters with delete keys.

Difficulties with Specific Functions. Certain kinds of problems recurred for specific functions. For example, when logging onto the ICON, some students found that their passwords were invalid and spent a class period trying various password combinations. (There was confusion over whether or not to use capital letters or a combination of both and whether the O was "o" or "O" or "0".)

Perhaps the greatest source of frustration for students using the computer was the number of problems associated with saving their writing. Mistakes in this seemingly simple procedure resulted in entire writing episodes being lost in the final minutes of the class. In the worst instance, 38 % of students in one class lost their work one day. A frequent error was that students merely forgot to save their writing even when the save feature was explained to them. In one school, the computer earned the reputation of being a malevolent

devourer of words, so that fewer and fewer students were prepared to volunteer when they had the choice.

Other Technical Problems. When many classes were using the ICON system throughout the year, space to save work became filled, and students had to select which of their files to delete. This took considerable class time that should have been used for writing. In classes using microcomputers, work was saved on floppy disks, which meant that students had to have their disk with them each day. If they did not, they had to borrow a disk from another student or ask the teacher for a spare. Not unexpectedly, disks became lost. In one instance, a teacher misplaced a disk containing four students' essays. Neither a backup disk nor printouts had been made. In another class, students kept losing their work because the computer cables became loosened. The computers sat on lightweight tables that were arranged in such a way that they were constantly being bumped by people walking about the room.

Problems with the Printer. Printers presented another set of problems. Sometimes the printers were not working at all, at other times, paper jammed as it fed through. Often, there was not enough computer paper to allow students to receive a printout of each session's work. There were frequent lineups of students wanting work printed. Consequently, some students limited their composing time in order to be able to print their work within class time.

Typically, there was only one printer per group of students. For students using microcomputers as opposed to the ICON, only one computer was connected to the printer. This meant that students needed to trade machines and reload their files to be able to get

printouts. Compounding this was the fact that many students wanted second or third printouts after seeing errors in the formatting of their texts.

There were also problems with print commands. In one class, several students using the ICON computer repeatedly typed the command to have their work printed before they realized the printer was not turned on. When the printer was turned on, it produced repeated copies of each essay -- the number of copies matching the number of times that the student had pushed the "action" key. Neither the students nor the teacher could find a way to cancel the command to the printer, and by the end of class, copies were still being churned out.

Teacher Attitude. A less tangible factor was the attitude of the classroom teacher to the computers. Some teachers were clearly machine-shy. They had never used a computer themselves and were totally unfamiliar with its possibilities. (This posed less of a problem in our study, since all the research observers were comfortable with computer use, and intervened to instruct and model when necessary.) Some were not familiar with the specific machine in use in the class -- the ICON for example -- and were not motivated to learn. Finally, sometimes even those who used the computer extensively kept at a distance, perhaps reasoning that they themselves had learned on their own and it was better to give the students the same scope. Some seemed to regard the computer as a fellow-teacher, entrusting the students' instruction entirely to the machine.

Summary

Clearly, many of the factors that militated against the successful introduction of the computer into a writing class are remediable. More effective and appropriate early instruction, reminders concerning basic commands posted in the classroom for in-process guidance, greater accessibility -- all these are possible, and in fact characterized the three classes described earlier, whose computer situations were close to ideal. Further, as the comparison in the revision analysis shows, in such classes the computer was in fact used far more extensively to achieve real change in the composing process. The technical circumstances do make a difference. Consequently, in Chapter Eleven describing pedagogic implications, we will present a series of guidelines for teachers intending to introduce the computer into the writing class, based largely on our experiences in the principal and supplementary studies.

However, as is clear from the description of the various technical difficulties, not all the problems are amenable to remediation. Thus, even when the Save Function is simply and clearly spelled out on a reminder posted in the classroom, some students will forget to save. When using microcomputers, some students -- and some teachers -- will forget their disks. The possibilities for human error are no greater with the computer than in writing by pen; after all, students forget their first handwritten drafts at home too. The point is that with the computer, however, the consequences of human error are far greater. Whole texts can be wiped out, whole files. Further, the number of humans on whom the production of each text is dependent is greater: the writer, peers, the teacher, the lab

monitor, the computer teacher, the janitor who handles the electricity, any visitor who trips over the cables.

Further, the technology itself is subject to failure in a way that is not possible (or does not matter) with pen and paper. Of course, a pen may run out of ink, but replacement is quick and easy. Computers do break down, and they are not easy to repair -- certainly not by the student or writing teacher. There were very few sessions observed in which at least one computer, or printer, or disk drive, was not "down".

Finally, in addition to all these factors, there is the fundamental issue of accessibility that cannot be solved by increasing the number of computers or the number of hours in which the computer lab is open. In the final analysis, you can write anywhere and any time with pen and paper -- and in just about any position. The computer, in contrast, imposes severe constraints in time and space.

In the end, it must be recognized that writing with a word processor complicates and constrains the process in a way that is not true of paper and pen. Consequently, writers will need to be convinced that the new technology is not only just as good, but considerably more advantageous than the simpler, more comfortable, and far more reliable technology they have already mastered.

PEN VS. COMPUTER

As suggested in the two preceding sections, the pedagogic and computer-related circumstances of the principal study were not always ideal. Not all classes experienced a process approach to writing,

and many of the computer classes were constrained in ways that are unnecessary. For this reason, the two supplementary studies were conducted in which both writing pedagogy and computer accessibility were closer to the ideal. The findings from the principal study will only be discussed in the context of potential qualifications suggested by these supplementary studies.

Revision Analyses

The advantage most commonly ascribed to the use of the computer in the writing process is ease of revision. Marcus (1984) was representative when he wrote of computer text as "words written in light, a fluid medium that offers little resistance to physical manipulation" (p. 58). Consequently, a principal question that was asked in the current study was whether students do in fact revise more when using a word processor.

In both the principal as well as the supplementary studies, the results of the revision analysis were all in the same direction: at all grade levels, students made significantly more revisions when writing by pen. This was true of all the revision operations, addition, deletion, substitution, and reordering, as well as of all levels of revision, word, phrase, sentence, idea unit. In other words, rather than facilitating change, as early proponents claimed, the computer seemed to impede revision.

Furthermore, at least at the Grade 12 level, this increase in the number of revisions had implications for quality. When raters made forced-choice evaluations of first and final drafts of scripts that had been subjected to considerable revision, either by pen or

computer, between 60 and 70% of the texts were deemed to have been improved. What this implies is that, because the students were revising less on the computer, they were not making improvements of which they were capable to their drafts.

One final insight provided by the revision analyses damned the computer from another perspective. For the one Grade 8 class where both computer accessibility and writing pedagogy seemed close to ideal, there was no growth in the number of revisions between the pre-test and the post-test, that is, over the course of the entire year. This stands in marked contrast to a matching Grade 8 class, whose pedagogy was similarly process-oriented but where the writing was entirely by pen. Whereas these latter students learned to revise more extensively and more profoundly over the year, those students who spent much of the year composing on the computer seemed stalled.

The reasons for this are not clear. Did the technology provide the kind of barrier between the writers and their texts that Bailey (1985) described? (See Chapter Two.) Or was the energy and the attention that went, for the pen-and-paper students, into developing their craft, absorbed by the computer students into learning how to assimilate the new technology? The description of student processes and behaviours in later sections may provide some explanations for these phenomena.

Fluency

While the results of the revision analysis pointed in the same direction throughout the studies, a simple word count revealed different patterns depending on grade and level. At the Grade 8 and

Grade 12G level in the principal study, students were more fluent with pen. The 12A students, however, in both the principal and supplementary studies, were more fluent on the computer. That is, the Grade 12 advanced level students produced longer texts when writing on the computer.

These conflicting results might be explained by differences in maturation: as students mature, they are better able to assimilate the new technology and to extend its use. There were, however, differences in the circumstances of production, especially in the principal study, that may have biased these results. Thus, at the Grade 8 and Grade 12G level of the principal study, time or space constraints were implicitly or explicitly placed on the composition of specific pieces. This was especially true for those using the word processor at the 12G level, because students knew they had limited computer time. In contrast, some of the 12A students in the principal study were given unlimited time at the computer, with no specific deadline or task. Needless to say, such circumstances favoured the production of lengthy, highly elaborated pieces.

For the Grade 8 computer class where circumstances were close to ideal, as well as for the Carleton study, the findings for word length point in the same direction as that suggested above: greater fluency with pen at the Grade 8 level and greater fluency with computer for Grade 12A. However, the numbers for these two groups are not great enough to allow for statistically significant results, and so the pattern suggested by the data must remain a hint to be explored in further research.

Rhetorical Analyses

As the survey of research in Chapter Two revealed, there have been mixed findings in the literature as to whether computer use results in qualitatively superior texts. Consequently, one objective of our study was to address precisely this question.

In order to determine the impact of word processor use on the quality of the scripts produced, comparisons were performed on sets of pen and computer texts, at the Grade 8 and Grade 12 level, in both the principal and the supplementary studies. Each set included two scripts -- one produced with pen and one on the computer -- by the same student. (Since Supplementary Study B matched enriched with advanced students, its results were considered highly suspect and consequently will not be included in this discussion. In the Carleton Supplementary Study, in contrast, matched scripts by the same students were generated in similar circumstances and consequently its findings are very revealing.) Further, at both the Grade 8 and Grade 12A levels, classes whose pedagogy and computer accessibility were close to ideal were involved in these comparisons. The instrument for assessing quality included ten rhetorical criteria, each specified according to a ten-point scale.

The only statistically significant result uncovered in analysing all the scripts at the Grade 8 and Grade 12 level, in both the principal and supplementary studies, according to each of the rhetorical criteria was in the degree of unity at the Grade 8 level. The pen scripts were considerably more unified.

This difference with respect to unity dovetails with the self-analytic comments made by several students in the Carleton

Supplementary Study. For different reasons, in each case, they argued that the computer interfered with their capacity to order texts. One felt that the problem arose from the limited amount of text visible on screen. Another argued that the cursor forced one's attention to the micro level. And yet a third, whose insights were corrobrated in our case study of Derek, explained that a layer of ordering came into play while composing by pen that was absent when he composed on the computer.

What is interesting is that, despite these comments, at the Grade 12 level, there are no significant differences in the degree of unityfor computer- vs. pen-produced texts. The standard deviations, however, are such as to suggest that there may be counterbalancing tendencies in both directions, that is, that for some students the computer imposes constraints with respect to ordering, while for others, the computer facilitates organization. And certainly, the sharp differences in attitudes to the computer revealed in the Carleton Supplementary Study corroborate this notion of distinct composing styles, some of which profit from and others of which are hampered by computer use throughout the process.

In fact, the standard deviations for all the rhetorical criteria are such as to be consistent with the existence of variation by composing style. There is, of course, an alternative explanation for the statistical facts: the standard deviations may simply point to a random variation about the mean. Certainly further research is necessary to confirm the existence and explore the nature of any differences by composing style; the introspective analyses by the Carleton study students, however, are highly suggestive and

corroborative of such notions.

High vs. Low Students

Several studies reported in the literature found differences in achievement with respect to computer use especially for basic students, or those at the low end of the ability scale. Our own inquiry, however, found no differences, either between general level and advanced students at the Grade 12 level, or between those defined by their teacher as low-achieving and high-achieving at the Grade 8 level. The discrepancy between our results and those of our studies may simply come from the definition of basic students. At the college level, such students in the United States are typically those from culturally and socio-economically disadvantaged backgrounds, who have often not completed their postsecondary schooling. It may be that this degree of disadvantage did not exist for the students in our population. Comparatively, Ottawa has a relatively homogeneous population socio-economically, if not culturally. Consequently, those who are defined as low-achieving students at an Ottawa board may perform at a considerably higher level than those so defined in the various American studies. Whatever the reason, our study showed no differences between high- and low-achieving students.

Classroom Behaviours

The results of the text analyses, then, show at best no overall differences between the two conditions and, on several measures, such as degree of revising, a considerable advantage to the pen. The question that remains to be answered is why. Specifically, why did

students revise less on the word processor when the computer technology seems to make the revising process so much easier, so much neater? Analysis of their classroom behaviours pointed to some explanations.

First, the code sheets recording overall classroom behaviours revealed that students composing on the computer spent a significant portion of their writing time (well over 20%) on activities related solely to the technology -- formatting, working and waiting at the printer, etc. In other words, the computer students ended up with less time on the task of composing than did the students who wrote by pen. This is especially ironic since one frequently vaunted supposed advantage of the computer is its time-saving capacity.

In addition, the computer students spent much less time on those activities associated with a process approach to writing: conferencing with teacher or peers, discussing work in progress, etc. That is partly explained by the phenomenon described above: after all the mechanical business was done, the computer students were left with less time on task. However, the remaining time should have been more evenly distributed and it was not. The shortfall came primarily at the expense of interactions with the teacher or other students over the text in progress.

One fact that became apparent in our study is that there is something isolating about computer use. Our observations of students writing at the computer (buttressed by discussions with teachers and researchers elsewhere) point to the hypnotic effect of the screen. Students spent far more time staring at the screen than they do looking at the paper on which they are composing. And this spell

seems hard to break, isolating students from interactions with others. As a result, computer writers spend far less time working through their texts with others.

The Carleton study students became absorbed by the screen when they were writing on the computer even though they were seated directly beside another student, whose screen was easily visible. However, when they began to write with pen and paper, these same students sought each other out, chatted continuously, and moved around the room, exhibiting the kind of restless behaviour that is so irritating to teachers, but that in this case seemed in the end to be so productive for the writing.

The Carleton study students did interact with the teacher in both the pen and computer conditions -- mainly because the teacher walked around the class and insisted on so intervening. Most process classes, however, are structured in such a way that it is up to the student, for the most part to initiate interactions with the teacher -- because there are so many students to see and because it makes more sense to allow the writer to determine the point at which a reader's response is necessary. In most of the process classes observed for the principal study, students were expected to initiate a dialogue with the teacher, and the computer students rarely did so.

To sum up then, analysis of classroom behaviours revealed that, in fact, the computer students were left with less time on task because of the large number of computer-specific activities to which they needed to attend. In addition, students writing with pen and paper spent far more time interacting with teachers and with peers over their work in progress. Consequently, the computer

students were exposed to a far more limited version of the process approach. That they revised less seems inevitable.

Composing Patterns

Analysis of the videotape records of individual students' composing behaviours on screen pointed to another potential limiting factor in computer use. By simply timing those behaviours that were specifically computer related, such as logging on, issuing commands, and especially correcting typographical errors, we discovered that, on average, 25% of the students' time in front of the computer, for both first and later drafts, was devoted to computer-specific activities. (These computer-specific behaviours are largely different from and in addition to the computer-specific classroom activities specified above -- which involve principally such activities as waiting at the printer, asking for clarification of commands, etc. The VCR anaysis provided evidence of what was going on during those activities coded as composing and revising on the classroom observation sheets, and it is 25% of these activities that were computer-specific.) More significantly, the time devoted to computer-specific activities was not concentrated at the beginning or end: it was distributed throughout the composing, and was given over especially to the correction of typographical errors.

This finding provides a further insight into how the technology affects the process. As a result of using the computer, students lose time while they are composing. Far more significantly, they lose track. They are distracted from what should be their primary focus in composing. The correction of typographical errors, in

particular, is the greatest distractor, a persistent hiccup in the process.

In her 1979 study analysing the behaviour of basic level writers, Sondra Perl described the way in which constant editing derailed the composing processes of such students. Rather than focusing on the emergent meaning of the developing text (as experienced writers do), such students kept attending to the surface features, which should have been held in what Polyani (1964) refers to as subsidiary awareness. Computer technology invites just such a derailment. Students who should be struggling with their meaning are persistently distracted by the typographical errors dancing on their screens.

Of course, students composing on a computer need not be so distracted; they can be encouraged instead to avoid making any corrections until the whole draft is complete -- in precisely the same way as they are encouraged to ignore spelling errors and mechanical problems until the copy-editing final stage by writing process teachers.

The point is that currently, for many students, aspects of the computer technology are interfering with the composing process, and it is this interference that may be leading to the less favourable results we have seen with computer use. If such is the case, teachers who intend to allow students to compose with a computer must be on their guard against these dangers. A specific pedagogy for writing with the aid of a computer is necessary. For example, in order to fight the hypnotic, isolating effects of the screen, conferencing time -- away from the computer -- will need to be

structured into class time. (Students might also be encouraged to work collaboratively on screen -- either to create texts together or to try out revisions in each other's pieces.) Teachers may also have to schedule fixed times for student interviews or fixed points in the process when students must consult with them.

In addition, students need to be warned against the derailing possibilities of computer use, specifically the seductiveness of correcting typographical errors en route. Explicit discussions about this danger, accompanied by appropriate teacher modelling, are both necessary. (Using a blind screen, however, as one researcher has suggested, is not the answer, since it prevents the kind of rereading during the process that is necessary for many good writers, as Pianko, 1979, has shown.)

Using the Pen in the Process

Teachers and students alike may need to expand their notions of the possibilities with respect to composing. The either/or option is too limiting, that is, either you write with pen or with the computer. One of the intriguing results of this study had to do with pieces in which the first draft was composed by pen and subsequent drafts on the computer. Revision analyses revealed that such writing was subjected to significantly greater modification than pieces composed entirely on the computer. Changes in the pen/computer condition were comparable in number to those in the pen alone condition, and the instances of such production (that is pen/computer) occurred almost entirely in classes where the computer circumstances were far from ideal. In other words, it is possible

that composing a first draft by hand and revising on the computer may be a particularly productive way of operating.

This suggestion was corroborated in the Carleton Supplementary Study in which nearly every student turned to pen and paper at some point during their composing by computer. Some brainstormed ideas on paper, others needed to begin their composing by pen; some freewrote when they were blocked, and one student composed her entire first draft by pen and transferred it to the computer.

The implication of both these observations and the revision analysis is that students should not be locked into one condition. Classrooms should be organized in such a way, both logistically and pedagogically, that students can move from pen to computer, from paper to screen, for different pieces as well as at various points in the composing of specific pieces.

Recently, Seymour Papert, an early apostle of the computer, has taken to warning against the danger of technocentrism; in writing too, we must be on guard against giving the computer centre-stage. Our primary focus, as teachers of writing, must be on the individual student and the composing process: we must learn consequently how to assimilate the new technology to the composing processes of the various learners in our classrooms.

Computer-Specific Composing Strategies

Other kinds of possibilities need to be explored as well. Analyses of the revisions students made composing their first drafts on the computer revealed that they made the same number and kinds of changes on screen as they did on paper when writing with pen. In

other words, on the whole, they were using the same repertoire of composing strategies with both technologies. This is consistent with the finding of other studies (Nichols 1986, Schipke 1986) which have shown that students simply tend to import wholesale the same set of behaviours and strategies that they have acquired writing with pen to the computer condition.

This is natural, but limiting. Clearly the technology of the computer allows for a range of composing strategies that pen and paper do not permit. In-process revision, for example, is far easier, and consequently, a different kind of composing is possible -- one in which the recursive process (of planning, composing, revising) is much tighter, where small segments are continually being revised rather than whole drafts.

Such a process may, or may not be, comfortable for specific writers. It may be that for some students, pen and paper will remain the most empowering. For others, the pen may be necessary for the first draft -- or to begin that first draft, in order to get a sense of the overall flow -- and that at a later point, the relative indelibility of pen and paper will be rejected in favour of the malleable screen. And there may be some for whom the tighter recursive processes allowed for by the computer will be the most enabling.

It is important, however, that the range of possibilities be explored by students so that an intelligent choice can be made. Teachers will need to model and to elicit those composing strategies made possible by the malleable screen. In other words, in introducing the computer to the writing class, teachers will need to

extend and modify their approach to the teaching of writing. In the preceding section, it was argued that students need to be shown not just how the machine works but also how it can be assimilated into the process; in this section, we argue that students also need to be shown how the composing process itself can be profitably reshaped as a result. In the end, students will need to understand far more fully the range of possibilities afforded by the screen before they can decide when and whether to use a word processor, and consequently before a fair measure of the computer's value can be taken.

Conclusion

To sum up then, the response to the original question posed in our study is complex. First, observation of various classes using computers revealed that current educational realities are such that there are many technical factors militating against the successful introduction of the computer into the writing class. Further, even if and when all remediable factors are remediated (in ways suggested in the next chapter), the computer will still inevitably complicate the process in ways not true of pen and paper. The advantages, consequently, will need to be considerable to outweigh the constraints imposed by dependence on a machine.

The most striking finding of our analyses of the texts produced by pen as opposed to those composed on a word processor was that students at all levels revised more by pen -- even in circumstances that seemed ideal such as when the teaching was process-centred and the computers as accessible as possible in a classroom setting. Observations, however, revealed that the technology was interfering

in important ways with the teaching as well as the composing processes. Thus, students on the computer were involved in less of a process approach than their peers with pens -- partly because of the time swallowed up by computer-specific activities, and mainly because of the isolating, hypnotic effect of the screen. In addition, the composing itself was interrupted persistently onscreen -- because of recurrent attempts to correct typographical errors.

Both these disadvantages of the technology are potentially remediable. Classes can be structured in such a way as to break into the hypnotic spell cast by the screen and to orchestrate as much interaction over texts in progress as in the pen condition. Further, students can be warned against the persistent correction of typographical errors en route. The point is that pedagogy will need to be altered in order to accommodate the new technology.

In addition to compensating for the potential disadvantages of the technology, teachers will also need to show students how to take full advantage of its potential benefits. Students will need to learn new sets of composing strategies, made possible by the malleable screen. Rather than simply doing the same on the computer, transferring their pen and paper strategies to the screen, students will need to be shown how to extend their repertoire to include those composing strategies compatible with the fluidity of the screen.

When teaching and composing strategies are extended to take full cognizance of the limitations and strengths of the computer, then and only then, will it be possible to make intelligent decisions as to computer use -- at the level of the individual deciding whether, when, and how to compose on the computer; and at the level of

curriculum planners, deciding whether, when, and how to introduce the computer into the writing class.

CHAPTER ELEVEN: PEDAGOGIC IMPLICATIONS

The jury is still out, then, as to the potential value of the computer in the writing class. What is clear, however, is that, given most current educational realities, the new technology impedes rather than enhances the process for many students.

For that reason, in the following sections, we will suggest ways in which teachers can facilitate the introduction of the computer into their writing classes should they decide to embark on that experiment. And we stress the word "experiment", for to date, the relevant research has not yet been performed that would test the value of the word processor in classes where the technical circumstances, and especially the pedagogic, are ideal, that is, ones in which the new technology has been assimilated into, rather than taken over the teaching and writing processes; and ones in which the teaching and composing processes have themselves accommodated the new technology. The discussion below makes an attempt to specify some of the features of the kinds of teaching that would allow the relevant experiment to take place.

Accessibility

A major problem identified in the principal study was that, for many classes, the computers were not easily accessible for a variety of reasons. Certainly, in no way can computers be made as easily available as pen and paper; however, computers can be considerably

more accessible than they were for many of the students we observed.

Minimally, when computers are first being introduced into a writing class, there should be at least one machine for every two students. With this number, an agile, experienced teacher will be able to conduct a whole-class writing-with-a-computer workshop, since at any one moment, half the students will be involved in conferencing, or working with pen and paper or printouts. Alternatively, half the class can be assigned to the computer for each assignment -- a somewhat less satisfactory solution, since a good deal of pedagogical attention will need to be focused on integrating the computer into the process. The point is that in introducing the computer into a writing class, teachers must reshape their own teaching -- so that the primary focus is not just the teaching of writing, but rather the teaching of writing on the computer. As we shall see, such teaching will imply different strategies, different kinds of class organization, and a different kind of pedagogic vigilance. It will be much easier, consequently, if the whole class is using computers -- at least until the students are all completely familiar with the different range of processes implied by word-processor use.

Location. The computers must be found in the same room as the writing teacher -- or vice versa. In situations where students leave the writing class to work on the computers in a lab by themselves, or under the guidance of a computer monitor, the opportunity for intervening tactfully at critical moments is lost to the writing teacher, and students working with word processors need such sensitive intervention far more than pen-and-paper writers.

Time. As to temporal accessibility, computers will need to be made available for sessions at least as long as regular composing sessions, and preferably longer, since the business surrounding computer use eats up so much time. Furthermore, computers must be regularly made available to students for out-of-class work, before and after school and at lunch-time, to give students at least some of the scope afforded by pen and paper.

Physical Setting

The physical setting in which the computer-assisted writing is done can significantly affect the success of the program. The guiding principle must be that whenever computers are used for writing, there must also be room for conferencing and space to write using pen. Unfortunately, computer labs, as they are currently designed, do not facilitate either student talk or writing by pen. Students and teachers should not have to squeeze between tables, step over connecting cables (possibly loosening them thus) or balance notebooks on their knees.

We offer the following set-up as a model for a writing workshop in which computers are part of the process. The classroom design is intended to be illustrative only; variations are possible and, in many cases, will be necessary.

Model Arrangement. Computers are arranged on wide tables along three walls, with the backs of the machines against the walls. Near the fourth wall are stationed a number of tables and chairs, grouped so as to allow for conferencing as well as solitary writing by pen.

The advantages of this structure are many. First, from the open space in the middle of the room, the teacher can see most of the computer screens. This allows her to watch for students who interrupt their process correcting typos, students who are blocked in their writing, and students who are merely playing with the reformatting of text. Second, both the teacher and the students can move around the room easily to engage in conferencing without interrupting others' work. Third, the table top on either side of the computer as well as the tables at the fourth wall allow students to use either pen or computer at various stages of the composing process.

Hardware and Software

The computers currently available in the schools all have their strengths and weaknesses; each machine, however, is capable of enabling that range of revising activities that are associated with word processing. Software packages do vary, and some are considerably more flexible and easy to learn than others.

Micro-computer Software. Rather than reviewing the packages we saw in use for the microcomputers, we will simply suggest general guidelines for selection of an appropriate package. First, it is advisable for teachers to become familiar with the basic commands of several packages. That is, they should learn how to log on, load, save, and manipulate text (insert, delete, and reorder small and large units). On this basis, a specific program can be selected according to the following criteria: range of text-manipulating commands (e.g., can one reorder text?); ease of manipulating text

(e.g., how easy is it to reorder text?); range of print commands (specifically, can one double-space?); and appearance of text on screen (specifically, are words broken distractingly mid-word at the end of the line?).

ICON Software. As to the ICON, it is essential to use the appropriate software. Many classes were using the ICON text editor as a word-processing package. Although a wide variety of text moves are possible, the text editor is tedious to use. For example, each time a new block of text is composed, margins have to be set. In addition, memorizing the significance of each ICON is complex. In contrast, WPRO, the new (summer 1986) word-processing program developed for the ICON is flexible, easy to learn, and menu-driven.

Word-Processing Instruction

At the beginning of the unit, students will need to be exposed to some instruction in word processing. It is important that the instructor be familiar not so much with the relevant computer but more specifically with the word-processing capacity of that computer and further, that the instructor refrain from discussing any aspects of the technology except for the basic word-processing commands. Too often, computer teachers and monitors are so enamoured of the technology that they cannot resist trying to impart some understanding of the technology itself -- or of its range of options.

All that students need to know is a handful of commands: how to log on, how to load, how to save; then how to manipulate text -- to insert, delete, and reorder. Computer programs that are menu-driven, like WPRO, eliminate memory work. When using microcomputers

that are command-driven, it is wise to pose the relevant commands at several points on the walls of the classroom.

Students learn most easily if they are asked to manipulate text themselves. A useful strategy is to describe the commands briefly and then to ask the whole class to work individually on a common piece of specifically prepared prose that will require all the relevant operations. Students can consult each other and will learn quickly by sharing problems and solutions. Typically, students become fluent on the word processor in a remarkably short period of time.

Trouble Shooting

Teachers, however, must be realistic. Even when the physical setting is ideal, even when there are as many computers as students, and when all the students are proficient at word processing, problems will arise. The technology is complex, and the equipment will break down. Sometimes disk drives will not load programs, at other times, printers will not print; on the ICON, sometimes passwords will not be accepted and occasionally memory will be exceeded. In such instances, it is most efficient simply to turn to the pen, rather than allowing students (or writing teachers) to become engrossed in trying to coax recalcitrant equipment.

Teachers must also resign themselves to the fact that a few students will lose at least one draft of their work initially. Even with repeated instruction, we found that some students forgot to save their work or made errors in saving. In the long run, these experiences are very effective pedagogically -- for the students and

their peers. In the meantime, all that can be done is to enforce the lesson and to encourage the students to start again.

When using microcomputers, it is advisable for teachers to keep several copies of the word-processing program ready in case the copy usually used for booting machines is mislaid. In addition, several spare disks should be kept on hand for students who forget their own at home. With the ICON, teachers should have several spare student password codes set up so that if anyone is unable to log on, he or she will be able to access one of these alternate files.

And finally, it is important for teachers to acquire their own keys to the computer room. On more than one occasion, we saw valuable class time lost as students or teachers went searching for someone to unlock the room.

The Writing Teacher and the Word Processor

Teacher apprehension about using the computer is common (although no student, male or female, in our study seemed machine-shy). Quite simply, if the writing teacher is not prepared -- for whatever reason -- to compose on the computer, there is no point introducing the machine into the writing class. For a long time now, those at the forefront of writing pedagogy have insisted that successful teachers are those who write themselves. In the same way, for the success of their programs, it is essential that the teachers who intend to elicit writing on the computer be comfortable with that process themselves.

This does not mean that a writing teacher must become an expert in technology or that he must spend hours deciphering the manual.

All that he must learn with respect to the technology is what students must learn -- the basic commands.

Beyond the basics of word processing, however, teachers who intend to teach writing on the computer must also have experimented considerably by composing various pieces with the computer. In fact, the best kind of preparation is a workshop, in which writing teachers compose with word processors and then share their experiences with each other -- their apprehensions, the pressure of the computer on their usual processes, the new strategies developed in response to the technology.

Professional Development. In other words, considerable professional development must be offered teachers who intend, or are expected to introduce writing with a computer. First, teachers must themselves be taught the basics of word processing as well as the simplest strategies for imparting this knowledge to their students. More significantly, teachers must be shown how the computer affects the composing process, how it is best integrated consequently into the process, and how writing pedagogy must be reshaped in response to the new technology. The section below describes some of the ways in which pedagogy can respond to word-processor use.

Pedagogy

As the discussion in Chapter Ten has suggested, the cornerstone of the successful introduction of the computer into the writing class is appropriate pedagogy. There are two guiding principles. First, the computerized writing class, like all writing classes, is best conducted as a workshop in the spirit of the process approach, as

dramatized by Graves (1983) and Murray (1985), and described in Chapter Four. Second, the computer must be seen as a tool in the writing process -- not an object for learning in its own right. Because of the mystique surrounding its use, because of its newness, and because of its imposing size, the computer has tended to dominate those classes into which it is introduced -- for some students and teachers, taking centre stage and absorbing all their attention and enthusiasm; for the machine-shy, looming menancingly at the periphery of their vision despite their averted eyes. To be useful in the writing class, the computer must be domesticated.

What this means is that, after the initial instructional sessions in which the basic commands for word processing are introduced, the technology should fade into what Polanyi (1964) has called subsidiary awareness. The computer must be recognized as one tool for composing, the pencil, another, each with its distinct role.

To achieve this domestication, teachers and students will first need to become fluent in the basic word-processing commands. In other words, initially full attention will need to be given the computer -- so that its operations become automatic. The analogy is with the microscope or telescope. A session or two must be devoted to learning their use; after that, one looks through them -- not at them.

In fact, learning to use the basic word-processing commands, in the manner suggested in the preceding section, is astonishingly easy. Within less than an hour the Carleton study students were completely at ease with their machines and the software. Once the commands essential to the production and revision of text are learned,

composing can begin. At this point, however, vigilance must be exercised against the seductiveness of the machine, so that students are not lured away from their main task by the panoply of technological possibilities -- with respect to formatting, for example, or printing.

Teacher Modelling. It is important that students be given considerable scope to explore the possibilities of the computer themselves. At the same time, though, they can profit from suggestions. To this end, the most useful strategy, one which points to possible directions without constraining individual exploration, is teacher modelling.

Basically, what the teacher must model is how to assimilate the technology into the composing process, and this means that a range of options must be dramatized, because different students will effectively use the computer at different points of the process, and in different ways. Composing a whole piece, from beginning to end, on the word processor is one option. In addition, students need to be shown how pen and paper can be used in tandem with the computer in their composing. Teachers should model a variety of processes in which the pen is introduced at different junctures. For example, in one instance, a teacher can show how the initial generating can be done on paper -- brainstorming, tree diagramming, clustering -- while the first and subsequent drafts are composed directly onto the computer.

On other occasions, the teacher can dramatize how, in the midst of producing text on screen, a writer can turn to pen and paper -- either to outline future sections or to free-write when the writing

seems blocked. Finally, it is important to legitimize the patterns of those who prefer to produce their first drafts (or the beginning of such drafts) on paper, relying on the word processor primarily for later-stage revisions. In other words, teachers should dramatize ways in which the two technologies can mesh, allowing each student to repond to inner necessities at each stage, and to explore the range of options for such meshing.

Forestalling Problems

There were two counterproductive patterns associated with computer use in the study: many writers became absorbed by their screens at the cost of productive interactions with peers and teachers over their texts; sometimes, students became derailed in their composing by focusing on typographical errors. Specific pedagogic strategies will need to be developed to deal with each of these.

Ensuring Interactions. In most process classes, teachers orchestrate the writing of the first piece, so that students experience the power of talking through their texts with their peers. Typically after this initial highly structured and stage-managed sequence, students are encouraged to write at their own pace, turning to their peers as needed during the process, both for generating ideas and for suggesting revisions.

In the computer class, more intervention may be necessary -- to counter the hypnotic effect of the screen. First, it may be necessary to organize several run-throughs of a complete process with the students in which specific time for interactions is scheduled

before and after each composing episode. Subsequently, it will be up to the teacher to scan the class regularly in order to ensure that writers are indeed interacting regularly. If not, various artificial interventions may be necessary. For example, students can be asked to keep a log for the writing of each piece, a log to be signed by their peers as proof that specific interactive activities have taken place. Alternatively, class time can be assigned at the beginning and end of each composing session for interactions.

Similarly, teacher conferences may need to be scheduled, if the students seem reluctant to leave their screens. Of course, during the composing sessions, some time should be allowed for teachers simply to circulate around the room, interacting with students over their unfolding texts on screen.

Interruptions to the Process. Once the commands are learned (and if the software is reasonably comfortable), the major persistent interruption to the process is correcting typographical errors. Teachers must warn students explicitly about the dangers of derailing their processes in this way. Just as in the early years, children are encouraged not to worry about the spelling of specific words as they compose their first drafts, so must novices at the computer be encouraged to keep their attention on their unfolding meaning, rather than on the surface aspects of the words appearing on the screen. The interviews with the Carleton study students revealed how perceptive and self-aware students, at least at the Grade 12 level, can be with respect to their own processes. For such students, explicit discussions of ways in which to guard against counter-productive tendencies may prove to be very successful. In addition,

scanning the screens of students as they compose will reveal to the writing teacher which students need tactful reminders to keep their primary focus away from surface features and on the unfolding meaning of their texts.

Extending the Repertoire

The impermanence of words on screen also makes it easier for teachers to make written comments to students about their unfolding texts. Questions and suggestions of any length can be inserted easily, either during class or at the teacher's convenience, and are accepted more readily because they need never appear in printed form.

More significantly, the computer facilitates certain kinds of composing and especially revising activities. For example, the computer makes it far easier to generate a series of options for any particular portion of text and to compare these in the context of the whole piece. Students who have been exposed to sentence combining exercises, for example, can be urged to combine several sentences in different ways -- leaving them all on screen -- to see how they mesh with the rest of the text. Consequently, teachers can profitably intervene as students revise on the computer to elicit a range of revising activities not possible with pen and paper.

Conclusion

The implicit (and sometimes explicit) theme of all the preceding sections has been that the writing class must be adapted in important ways -- physically, organizationally, pedagogically -- if the computer is to be introduced successfully. It is naive to expect

that, simply by making a computer lab available or by dropping a few computers into the corner of a room, students will be able to assimilate the new technology in a way that is productive for their writing. It is equally naive to expect that teachers will be able to adjust their pedagogy to enable students to assimilate the technology without considerable support and professional development.

The writing class will have to change in important ways, as will the teacher's approach to the teaching of writing. At the same time, the computer will have to be reconceptualized. Papert (1987) has written about the phenomenon of technocentrism which has placed the computer at the centre of our collective consciousness. We have all been guilty of such technocentrism, and perhaps it is as inevitable a stage of maturation as Piaget's egocentrism, which Papert points to as analogous.

It is necessary for us now, as a profession, to move beyond this technocentrism. We must recognize that in order to be useful to us -- as learners, as teachers, and as writers -- the computer will need to be domesticated. That is, the computer as word processor, must first be mastered completely and then re-envisioned in the context of our goals -- as learners, as teacher, and as writers. It is only after we have mastered this technology, and only after it has been domesticated to our larger purposes, that its true value, as an instrument in the attainment of these ends, will be known.

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APPENDIX A.1

PRE-TEST

Instructions

DAY ONE

1. On the first day tell the students something like the following:

   "In a few days, I'm going to ask you to do the following:

   > There are probably things happening in the world around you -- at school, among friends, at home, in the country, in the world -- that you think ought to be changed. Select one, and write a composition (or an essay or article) to convince someone else (preferably someone who has the power to make the changes) that what you object to is really bad and ought to be changed.

   You're going to have a chance to write two drafts, the first in one class period and the second a few days later."

2. DO NOT DISCUSS THE TOPICS IN CLASS AT ALL. Since we cannot control what individual teachers might do as prewriting exercises, we have to ask you not to do any, so that we can keep the conditions as uniform as possible. And please don't give the students last minute advice on structure, organization, or mechanics. Let them do their own planning, using whatever strategies they have available to them.

DAY TWO

1. A day or two after you have announced the topic, please devote a WHOLE CLASS PERIOD 40-60 minutes) to writing the first draft.

2. Write the topic on the board exactly as it is worded above, hand out writing paper if necessary, and tell the students you'd like them to write their first draft. Explain that they will have a chance to write a second draft in a few days time.

3. Do not specify any length; if they ask how long the paper should be, it should be as long as they need to say what they have to say.

4. Ask the students to use ball-point or felt-tip pens (not pencils).

5. Collect the first drafts at the end of the first class.

6. Do not read or comment on the first drafts, and do not suggest any revisions.

DAY THREE

1. On the next possible class (but not on the same day), return the first drafts to the students and ask them to write a second draft.

2. Do not help the students with their revisions. STUDENTS MAY USE A DICTIONARY.

3. In order to ensure a good copy, please make sure that ALL FINAL DRAFTS ARE WRITTEN WITH BALL-POINT OR FELT-TIP PENS.

4. Staple the final copy to the first draft with the final copy on top.

APPENDIX A.2

POST-TEST

Instructions

DAY ONE

1. On the first day tell the students something like the following:

   Choose any controversial issue that interests you, and write an opinion piece, arguing one side or the other. The issue can be one that relates to your home or family (such as, "Nobody should have to share their bedroom"); your school (such as, "Everyone should be allowed to fail one subject,"); your community (such as, "Smoking should be prohibited in all public places"); or the world at large (such as "Stockpiling nuclear arms will lead inevitably to nuclear war"). The examples listed above are only intended to show you the range of subjects that are possible. YOU CAN CHOOSE ANY TOPIC THAT YOU WISH. Write a composition, arguing one side or the other of the issue in order to convince a reader of your position.

   You're going to have a chance to write two drafts, the first in one class period and the second a few days later."

2. DO NOT DISCUSS THE TOPICS IN CLASS AT ALL. Since we cannot control what individual teachers might do as prewriting exercises, we have to ask you not to do any, so that we can keep the conditions as uniform as possible. And please don't give the students last minute advice on structure, organization, or mechanics. Let them do their own planning, using whatever strategies they have available to them.

DAY TWO

1. A day or two after you have announced the topic, please devote a WHOLE CLASS PERIOD 40-60 minutes) to writing the first draft.

2. Write the topic on the board exactly as it is worded above, hand out writing paper if necessary, and tell the students you'd like them to write their first draft. Explain that they will have a chance to write a second draft in a few days time.

3. Do not specify any length; if they ask how long the paper should be, it should be as long as they need to say what they have to say.

4. Ask the students to use ball-point or felt-tip pens (not pencils).

5. Collect the first drafts at the end of the first class.

6. Do not read or comment on the first drafts, and do not suggest any revisions.

DAY THREE

1. On the next possible class (but not on the same day), return the first drafts to the students and ask them to write a second draft.

2. Do not help the students with their revisions. STUDENTS MAY USE A DICTIONARY.

3. In order to ensure a good copy, please make sure that ALL FINAL DRAFTS ARE WRITTEN WITH BALL-POINT OR FELT-TIP PENS.

4. Staple the final copy to the first draft with the final copy on top.

APPENDIX B.1

REVISION CODE SHEET

Case ID _____ -- -- -- --
Student Number _____ -- -- --
Script Number _____ -- --
Grade _____ --
Teacher _____ --
MODE _____ --

Additions
- Word _____ -- --
- Phrase _____ -- --
- Sentence _____ -- --
- Idea Unit _____ --
- Section _____ --

Deletions
- Word _____ -- --
- Phrase _____ -- --
- Sentence _____ --
- Idea Unit _____ --
- Section _____ --

Reorderings
- Word _____ -- --
- Phrase _____ -- --
- Sentence _____ -- --
- Idea Unit _____ --
- Section _____ --
- Whole Draft _____ --

Substitutions
- Word for Word _____ -- --
- Word for Phrase _____ -- --
- Phrase for Word _____ -- --
- Phrase for Phrase _____ -- --
- Sentence for Phrase _____ --
- Phrase for Sentence _____ --
- Sentence for Sentence _____ --
- Idea for Unit Exactly _____ --
- Idea Unit for Idea Unit with Deletion _____ --
- Idea Unit for Idea Unit with Addition _____ --

Entirely New Draft on Same Topic _____ --
Entirely New Draft on Different Topic _____ --
Partial New Draft _____ --
Deliberately Sketchy First Draft _____ --

Appendix B.2

RHETORICAL INSTRUMENT

UNITY

0, 1 There is no discernible thesis, no point of view or conclusion. Though the entire essay may be about a subject, it simply brings up random points.

2, 3

4, 5 The thesis is not sufficiently restricted or unified. For example, the writer is making two separate points that are related but not logically integrated, although potentially they could be; or, he is biting off more than he can chew -- the thesis is a little too broad for the length available.

6, 7 The thesis is restricted and unified, but not always clear.

8, 9 The thesis is clear, restricted and unified.

ORGANIZATION: LOGICAL, CONTROLLED

0, 1 There is no discernible order of presentation, with incoherent hopping from sentence to sentence and from paragraph to paragraph. Thoughts are rambling and uncontrolled.

2, 3 There are certain small sections that have a sense of sequence, but no overall sense of pattern for the whole essay.

4, 5 There is an overall pattern for the essay, but within these larger units there is frequently no pattern, no obvious development of idea.

6, 7 There is clearly discernible order in the essay as a whole as well as within each smaller unit, with only occasional lapses.

8, 9 The order is clear and convincing, leading the reader from idea to idea. The line of thinking begins in the introduction and carries through to the conclusion. There is no aimless moving back and forth. There is a general feeling of control and competence.

DEVELOPMENT: CONCRETE AND APPROPRIATE FILLING OUT OF THE SKELETON STRUCTURE

0, 1 The paper remains a skeleton, with no concrete details to support its sweeping generalizations, or what illustrations etc., it does use do not actually support the generalizations.

2, 3 The paper has made use of some appropriate examples, illustrations, etc., but these are only occasional and not always relevant or convincing.

4, 5 There is a fair amount of supporting detail; at the same time a fair number of generalizations are without any support and perhaps some of the details are not entirely relevant.

6, 7 Generally speaking, sufficient concrete and appropriate material fills out the skeleton structure with only the occasional lapse.

8, 9 The development is full, appropriate and satisfying, creating an impression of thoroughness.

REGISTER

(This includes diction, sentence structure and use of the conventions of the discipline)

0, 1 Slangy, colloquial.

2, 3 Informal with occasional lapses of colloquialisms.

4, 5 Informal.

6, 7 Formal, with lapses of informality.

8, 9 Formal.

OVERALL STYLISTIC EFFECTIVENESS

0, 1 The writer has little sense of language or style. One struggles unnecessarily to grasp his meaning. He stumbles over words and sentences.

2, 3

4, 5 There is no actual difficulty reading but the style is undistinguished.

6, 7

8, 9 A joy to read. A sense of control and grace. Either elegance without mannerism or simplicity without simple-mindedness.

SENTENCE STRUCTURE

0, 1 Short simple sentences predominate; longer ones are often distorted in logic or awkward. The sentences may use awkward inversions and may be difficult to understand.

2, 3 The sentences are generally correct grammatically and can be understood, but there is some awkwardness when the author tries for a more complex structure. There may be rambling phrases and clauses, misplaced modifiers, awkward parallelisms, etc.

4, 5 The sentence structure is correct and clear, without glaring monotony of construction or distortion of logic.

6, 7 The sentence structure is not only clear and correct, but there is considerable evidence of control over more complex and elegant structures.

8, 9 The sentence structure is consistently mature, varied, and clear, employing devices of balance and parallelism effectively and avoiding logical distortions.

RANGE OF VOCABULARY

(We are measuring range rather than precision -- what they use at all rather than what they use precisely)

0, 1 The range is very limited. The writer does not venture much beyond a very limited selection; there is frequent repetition and vague language. (e.g., type, kind, etc.)

2, 3

4, 5 The register is that of informal speech but the writer can make effective and varied use of that range.

6, 7

8, 9 There is a wide and varied use of the educated language, drawing on both the formal and informal ranges of discourse.

VIVIDNESS -- STRIKING EFFECTS IN DICTION; IMAGERY, WIT, ETC.

0, 1 The general effect is blah: monotonous, undistinguished.

2, 3

4, 5 There is an occasional flash of brilliance to relieve the humdrum.

6, 7 The style is quite striking at various points but not consistenty so.

8, 9 Without being mannered or cute, the writing is effective through its striking use of images, metaphors, or remarkable diction, or through its wit and irony, etc.

ECONOMY

0, 1 The writing is diffuse and repetitive.

2, 3

4, 5 The inefficiency is not blatant: there is little actual repetition but there are many needless words (which's, is's) and roundabout ways of saying things.

6, 7 The writing is economical and controlled with only the occasional lapse.

8, 9 The writing is elegant, spare, and efficient. Every word is used effectively. There is no flab.

READER_AWARENESS

0, 1 Unaware.

2, 3 Vague awareness.

4, 5 Acknowledges reader, but does nothing.

6, 7 Acknowledges; some success.

8, 9 Fully acknowledges; success.

APPENDIX B.3

OBSERVATIONS CODING SHEET OF STUDENTS' WRITING BEHAVIOURS

Class _____

Date _____

Talks to friends											
Plays (doodles/fixes files)											
Waits/listens to teacher help											
Talks to teacher about writing											
Pauses (sits/thinks/stares)											
Composes											
Recopies/types previous draft											
Edits (setup/typos)											
Rereads a) handwritten draft											
b) computer screen											
c) computer printout											
Revises (adds/deletes)											
Conferences a) reads draft											
b) listens											
c) discusses											
Asks/tells friend how to spell											
Asks/tells computer commands											
Reference use											
At printer											
Other activity											

Appendix C.1

COMPARISON OF REVISIONS PER 50 WORDS IN CLASS NARRATIVES OF GRADE 8 STUDENTS: PEN VS. COMPUTER

	Pen (n=31)		Computer (n=2)		F	p
	Mean	S.D.	Mean	S.D.		
Total Substitutions	1.5107	.9431	.0754	.1067	4.4941	.0421
Total Changes	4.2085	2.4096	.1775	.1756	5.4321	.0265
Changes at Word Level	1.8293	1.0276	.0754	.1067	5.6530	.0238
Changes at Phrase Level	1.5046	.9751	.0377	.0533	4.3931	.0443

Appendix C.2

COMPARISON OF REVISIONS PER 50 WORDS IN CLASS ARGUMENTS OF GRADE 8 STUDENTS: PEN VS. COMPUTER

	Pen (n=12)		Computer (n=28)		F	p
	Mean	S.D.	Mean	S.D.		
# of Drafts	2.7500	.9653	2.1429	.8483	3.9646	.0537
Total Additions	1.5172	1.0233	.2377	.2835	38.1753	.0000
Total Deletions	1.2530	.8433	.9273	.1872	48.6269	.0000
Total Reorderings	.0728	.1805	.0000	.0000	4.7169	.0362
Total Substitutions	.9294	.5804	.1743	.2957	30.0061	.0000
Total Changes	3.7724	2.2678	.5092	.5942	51.4200	.0000
Changes at Word Level	1.5506	1.0741	.1147	.1930	48.0495	.0000
Changes at Phrase Level	1.3047	.8258	.1778	.2683	42.9147	.0000
Changes at Sentence Level	.8259	.9060	.1294	.2556	14.3461	.0005

Appendix C.3

COMPARISON OF REVISIONS PER 50 WORDS IN CLASS NARRATIVES OF 12G STUDENTS: PEN VS. COMPUTER

	Pen (n=20)		Computer (n=7)		F	p
	Mean	S.D.	Mean	S.D.		
Total Additions	.9274	.7229	.1334	.2296	7.9772	.0092
Total Deletions	.7563	.5783	.1793	.4744	5.6007	.0260
Total Substitutions	1.3271	1.2161	.0000	.0000	8.1250	.0086
Total Changes	3.2290	2.1507	.3725	.7822	11.5529	.0023
Changes at Word Level	1.7549	1.2629	.2391	.6326	9.1068	.0058
Changes at Phrase Level	.9515	.8756	.0368	.0974	7.4170	.0116

Appendix C.4

COMPARISON OF REVISIONS PER 50 WORDS IN CLASS ARGUMENTS OF 12G STUDENTS: PEN VS. COMPUTER

	Pen (n=20)		Computer (n=7)		F	p
	Mean	S.D.	Mean	S.D.		
Total Additions	.9274	.7229	.1334	.2296	7.9772	.0092
Total Deletions	.7563	.5783	.1793	.4744	5.6007	.0260
Total Substitutions	1.3271	1.2161	.0000	.0000	8.1250	.0086
Total Changes	3.2290	2.1507	.3725	.7822	11.5529	.0023
Changes at Word Level	1.7549	1.2629	.2391	.6326	9.1068	.0058
Changes at Phrase Level	.9515	.8756	.0368	.0974	7.4170	.0116

Appendix C.5

COMPARISON OF REVISIONS PER 50 WORDS IN CLASS NARRATIVES OF 12A STUDENTS: PEN VS. COMPUTER

	Pen (n=36)		Computer (n=18)		F	p
	Mean	S.D.	Mean	S.D.		
Total Additions	.8252	.8024	.2166	.2232	9.8842	.0028
Total Deletions	.6819	.5063	.0931	.1072	23.5768	.0000
Total Reorderings	.1549	.1810	.0412	.1121	5.9321	.0183
Total Substitutions	1.2663	1.0170	.2540	.4095	16.3740	.0002
Total Changes	2.9283	1.9055	.6050	.7037	24.8586	.0000
Changes at Word Level	1.3316	.9508	.2591	.3705	21.1288	.0000
Changes at Phrase Level	1.0105	.8010	.2155	.3216	16.2844	.0002
Changes at Sentence Level	.5255	.5104	.0651	.1062	14.2037	.0004
Changes at Section Level	.0026	.0158	.0507	.0538	24.9020	.0000

Appendix C.6

COMPARISON OF REVISIONS PER 50 WORDS IN CLASS ARGUMENTS OF 12A STUDENTS: PEN VS. COMPUTER

	Pen (n=130)		Computer (n=29)		F	p
	Mean	S.D.	Mean	S.D.		
# of Drafts	2.2308	.9527	3.6207	2.0944	29.9768	.0000
Total Additions	.6771	.6336	.2770	.3321	10.8580	.0012
Total Deletions	.4611	.5054	.1486	.2111	10.6223	.0014
Total Reorderings	.1201	.1906	.0384	.0698	5.1584	.0245
Total Substitutions	1.0211	.9592	.3708	.4193	12.7340	.0005
Total Changes	2.2793	2.0010	.8348	.7679	14.5716	.0002
Changes at Word Level	1.0915	1.0329	.3038	.3745	16.3147	.0001
Changes at Phrase Level	.8637	.8918	.2689	.3170	12.4936	.0005

Appendix D.1

SUPPLEMENTARY STUDY A

INTERVIEW QUESTIONS

Name of Student _____

Grade completed in 1985/86 _____

Which English course did you take this year? (A or G) _____

What grades did you receive in writing course, English course, English essays, History essays?

How many essays did you write this year and last year? How long were they, were the topics assigned, and for what courses?

Why did you choose to volunteer?

Do you write out of school? What kind of writing?

Do your parents write at home or at work?

What do you read for pleasure?

Do you have a computer at home? What kind?

Do you use it for composing?

Have you taken a computer course?

How many fingers do you use to type?

Do you type faster than, about as fast as, or slower than you write?

Composing Patterns

Describe your typical process (according to the categories specified below) for EACH of the following: a) writing compositions for the writing course; b) writing out-of-class essays; c) writing out-of-class self-sponsored writing (if any).

1. How do you get a topic for your writing?
2. How do you generate (discover the ideas for your writing)? Through brooding, reading, free-writing, talking (with whom).
3. When you do research, do you just read or take notes or write personal responses to what you're reading?
4. Do you write the whole piece all at one sitting?
5. What kind of changes do you make?
6. When do yu make these changes -- while you're doing the writing for the first time (stopping every sentence -- or phrases -- or two to make changes) or at the end, after you've written a complete draft?
7. How do you know what changes to make?
8. When do you start worrying about spelling, punctuation, etc.?
9. Do you have anyone else read your writing? When? For what purpose?
10. Where do you normally do your writing?
11. How much time do you normally spend writing at any one sitting? How long can you normally concentrate on writing?

Appendix D.2

SUPPLEMENTARY STUDY A QUESTIONNAIRE

Name of Student _____

1. Do you think using the computer made a difference in the quality of your writing? Check one: it made the writing significantly better _____, somewhat better _____, about the same _____, a little worse _____, much worse _____.

2. With respect to my writing, the computer is (check one) a great advantage _____, a useful tool _____, just a fancy typewriter _____, a disadvantage _____.

3. In what ways, does the computer make writing easier?

4. In what ways, does the computer make writing harder?

5. Is it easier or harder to concentrate using a computer?

6. How frequently per session (per morning) did you use the following commands? Insert word _____ Insert sentence _____ Insert paragraph _____ Delete word _____ Delete sentence _____ Delete paragraph _____ Transfer word _____ Transfer sentence _____ Transfer paragraph _____

7. In what ways is your composing process different when you use a computer?

8. Do you make changes on the hard copy or on screen?

9. In using a computer, do you ever also start writing by pen? When?

10. Does the fact that there is only a small amount of text on screen bother you?

11. How did you enjoy using the computer as compared to writing by pen?

12. What changes occurred in the way you wrote over the two weeks?

P.M.I.: PLUS -- MINUS -- INTERESTING

The purpose of this strategy is to force one to examine an idea for its advantage and disadvantages rather than immediately accept or reject it. To do a P.M.I.

P -- List the PLUS aspects of an idea.
M -- List the MINUS aspects of an idea.
I -- List the aspects which are neither good or bad but are INTERESTING.

EXAMPLE:

Issue: Junk food should be banned in schools.

P: -- improved health
-- improved concentration
-- money saved by students

M: -- freedom of choice curtailed
-- difficult to enforce
-- economic repercussion

I: -- how should "junk food" be defined?
-- would this result in a lasting change in eating habits?

PRACTICE IDEAS:

1. School uniforms should be compulsory.
2. The strap should be used in schools.
3. Credit cards should replace cash.
4. Women should participate in organized sports with men.
5. Voting in federal, provincial, and municipal elections should be compulsory.
6. The school year should be extended to 12 months.
7. Family allowance cheques should be issued directly to all children as soon as they reach school age.
8. Smoking should be banned.
9. The lash should be used in federal prisons.
10. Exams should be abolished.
11. Free enterprise schools should replace government run schools.
12. By law, all cars should be painted yellow.
13. By law, every person should wear a button indicating his mood when in public.

Appendix D.3

DE BONO THINKING EXERCISES USED IN SUPPLEMENTARY STUDY B

C.A.F.: CONSIDER ALL FACTORS

Before a decision is made, it is wise to consider all factors. No judgements are made at this point; the purpose of the exercise is simply to note all important factors affecting a problem or idea.

EXAMPLE:

In the late 1800's, a prediction was made that life in New York City would be impossible by the year 1930 because by then, all major streets would be several feet deep in horse manure. This prediction turned out to be false because the prophet failed to consider the factor of a new form of transportation replacing the horse.

PRACTICE ITEMS:

1. The following is a partial list of factors that should be considered by a family before purchasing a house. What factors have been left out?
   - the price of the house, and the resale value of their present house
   - the downpayment required
   - the age of the home
   - the repairs required
2. Do a CAF on the factors involved in choosing a career.
3. Do a CAF on the factors involved in the decision to marry.
4. Do a CAF on the factors involved in designing:
   - the perfect bedroom
   - the perfect locker
   - the perfect school desk and chair